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Reenlistment behavior of nuclear-trained enlisted men

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THESIS

REENLISTMENT BEHAVIOR
OF NUCLEAR-TRAINED ENLISTED MEN

by

Richard Wayne Cook

June 1988

Thesis Advisor: Loren M. Solnick

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This thesis investigates reenlistment behavior of a particular occupational sector of the U. S. Navy. The data set consists of enlisted members with nuclear NECs and 4 to 9 years of service during the 1977-1987 time frame. Specific pay and employment data from the civilian nuclear industry is used for comparison to military pay. Two econometric modelling techniques are employed: logit analysis for individual level data, and time-series cross-sectional analysis for pooled data. The effect on reenlistment probability of changes in relative military and civilian salaries is determined. The results demonstrate the importance of pay to the reenlistment decisions of these men, but indicate that the supply elasticity is relatively low. It is argued that this low responsiveness of retention to pay changes is due not only to the arduous conditions of the work environment, but to the fact that military to civilian pay ratios were uniformly low during the period of observation. Previous research concerning the relationship of retention to pay has aggregated occupational categories and found higher elasticities. This paper shows that retention behavior can be better understood using information about compensation in disaggregated military occupational sectors and specific civlian alternatives.

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Reenlistment Behavior of Nuclear-Trained Enlisted Men

by

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Lieutenant, United States Navy
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Submitted in partial fulfillment of the requirements for
the degree of

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from the

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June 1988

ABSTRACT

The thesis investigates reenlistment behavior of a particular occupational sector of the U. S. Navy. The data set consists of enlisted members with nuclear NECs and 4 to 9 years of service during the 1977-1987 time frame. Specific pay and employment data from the civilian nuclear industry is used for comparison to military pay. Two econometric modelling techniques are employed: logit analysis for individual level data, and time-series cross-sectional analysis for pooled data. The effect on reenlistment probability of changes in relative military and civilian salaries is determined. The results demonstrate the importance of pay to the reenlistment decisions of these men, but indicate that the supply elasticity is relatively low. It is argued that this low responsiveness of retention to pay changes is due not only to the arduous conditions of the work environment, but to the fact that military to civilian pay ratios were uniformly low during the period of observation. Previous research concerning the relationship of retention to pay has aggregated occupational categories and found higher elasticities. This paper shows that retention behavior can be better understood using information about compensation in disaggregated military occupational sectors and specific civilian alternatives.

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I. INTRODUCTION

A. BACKGROUND

1. Motivation for this Study

In decisions about budgeting for defense, questions of efficiency are ubiquitous. The military services spend billions not only on tanks, ships, airplanes and other capital assets, but also on hundreds of thousands of civilians and uniformed personnel. This paper looks specifically at manning[1] in the Navy. It explores policy issues related to the use of monetary resources to affect retention[2] of nuclear trained personnel.

Military manning problems seem to occur in cycles, like many other things. Some recent predictions assert that recent successful times may soon end due to what has been called the "birth dearth" [Ref. 1]. The baby boom that followed in the wake of World War II was a boon to military recruiters, both directly because of the large numbers of potential enlistees in the population, and indirectly due to the loose labor market of which they were a part. Beginning in the early sixties birth rates declined, and the effects of this were felt in the late seventies when these people entered the work force and became recruiting targets. During the 1990s it is expected that there will be about 25 percent fewer nineteen-year-olds than in 1980. [Ref. 2: p.3] Since the services will have to attract a larger

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[1] "Manning" is used here as a gender-neutral term. It originated in a nautical context (e.g., manning ships) which even today is male-dominated.

[2] *Retention* is typically used when speaking of the decision to remain in service after successful completion of a term of enlistment. It is not to be confused with *attrition*, which refers to personnel leaving the military prior to the end of the first period of obligated service.

proportion of eligible youths to maintain present personnel strength, wage costs are expected to rise significantly.

The total cost of labor is not made up of wages alone. There are non-wage components such as hiring and training. These quasi-fixed labor costs are significantly affected by the rates at which people enter and leave an organization. The more stable the organization's membership, the less will be spent on hiring and training. In the military there are unique non-monetary benefits of stability. Morale and unit cohesion can be very important in a high stress combat environment. Stability is a factor influencing esprit de corps.

The focus here will be on retention of personnel in the nuclear Navy facing the first reenlistment opportunity. This study is not concerned with the initial enlistment or with second and subsequent reenlistments.

The military is distinct from other employers in that members are contracted for a certain period of service, during which time they are not normally allowed to leave. The vast majority of hiring is at the entry level. Enlisted personnel are mostly unskilled when they enter, and usually 17-20 years old. Thus a key selling point of joining the military is frequently the training that is offered. Much of this training is often applicable to civilian jobs. Part of the retention problems faced by the armed services has to do with the marketability of its personnel outside the service. As expected, the most serious personnel shortages usually exist in skilled ratings where the personnel have accumulated a high level of training.

This thesis will attempt to describe the relationship of pay to retention in the nuclear enlisted community.

2. Factors Influencing Retention

The intuitive relationship between pay and a person's choice of whether to belong to an organization has been repeatedly shown to be true empirically, both by defense-supported and independent civilian research. But the choice of where to work is also a function of numerous other factors. Studies have found age, race, gender, dependents and family composition, level of education, the business cycle, unemployment and economic conditions, family tradition, and organizational attributes such as job security, work atmosphere and culture, dispute resolution procedures, and perception of equity to be important. The list could go on. Usually, pay is thought to be predominant among these; perhaps because it is an easily quantifiable variable, and certainly because it is the one factor over which the organization's management may have the most control. Relevant findings of previous researchers will be discussed in the next chapter.

B. RESEARCH QUESTION

This study answers the following question. How well can reenlistment decisions be explained using information about the relationship between military salary and the salary available in a comparable civilian job? It is hypothesized that retention behavior of specific occupational groups can be better understood by considering their opportunities apart from those available to military members in general. Previous work has addressed this relationship for aggregated categories of occupations. This thesis will investigate the relationships within a particular category and compare the results to those obtained by other studies.

C. SCOPE OF THE THESIS

1. Boundaries

Many factors are involved in the reenlistment decision; the focus here will be on economic incentives. An additional bound is the restriction of the analysis to a specific occupational sector--nuclear trained enlisted men. The selection of this group is justified by the following observations.

These men are predominantly stationed at sea on combat ships. They will spend most of their early careers at sea. These ships are frequently undermanned, since recent retention problems have affected the number of crew members available for assignment to ships. Because various nuclear ship types--aircraft carriers, cruisers, and submarines--represent a large proportion, about 25 percent, of the Navy[1], their manning is of primary importance.

Nuclear trained enlisted men are above-average intellectually. Less than 35 percent of the 18 to 23-year-olds in the United States can meet the Navy's aptitude test qualifications for nuclear training [Ref. 3]. These men are responsible for the operation and maintenance of nuclear power plants in an atmosphere where supervision is close, tolerance for error is practically non-existent, and pressure and workload are high. All these characteristics contribute to the homogeneity of this group, and distinguish it from other categories of personnel in the Navy, even other sea-going ratings.

For over a decade the singularity of this sector has been recognized; there have been special pays associated with nuclear training and sea-duty, and lucrative bonuses for those who reenlist. These incentives can be thought of as compensating

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[1] 580 ships according to the FY89 Defense Budget.

for arduous work, but have developed primarily to compensate for shortages due to large numbers of nuclear trained personnel choosing to leave the Navy for careers in the civilian world. As a result of the differential pay existing now, a nuclear trained petty officer on a submarine is probably the most highly paid of his rank in the service.[1]

2. Limitations

As is the case with much social science research, the main limitation of a study such as this is in the data. To completely describe retention behavior of any group, it would be necessary not only to account for the inherent randomness of human behavior in general, but also to define all the alternatives to reenlistment precisely. This is obviously not possible. However, this study attempts to show that refinement of data and disaggregation of occupational groups can yield improved explanatory power.

D. ORGANIZATION

The following chapter discusses the existing state of knowledge on the subject at hand. Chapter 3 describes the methodology of this study and Chapter 4 presents data analysis and discusses the results in detail. Finally, Chapter 5 concludes with policy implications and recommendations.

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[1] A typical nuclear-trained first-class petty officer (pay grade E-6) with 6-10 years of service earned about $28,000 in 1986. His non-nuclear-trained contemporary earned about $19,000.

II. LITERATURE REVIEW

A. OVERVIEW OF THE RETENTION ISSUE

1. The Economic Perspective

Since the All-Volunteer Force (AVF) began, attention has been focused on ways in which the military service has changed as a result. The full import of the transformation from a system of conscription to one in which the military competes more fully in the free labor market is not immediately apparent. Some subtle but important effects of this change have been documented in the professional literature of manpower analysis.

The military has traditionally been institutional rather than occupational. Several features of the institutional military have been listed by Charles C. Moskos, Jr. [Ref. 4: p.42]: fixed terms of enlistment, 24-hour availability, military discipline and law, inability to unionize for collective bargaining, and the existence of non-cash forms of compensation. These characteristics align themselves well with a concept of a civic duty to serve, which has its origin in pre-revolutionary literature. But the institutional ideal of devoted soldiers performing in blind obedience to superiors has eroded in the last two decades.

While the enlisted force has never been entirely comprised of conscripts, the end of the draft brought the military more completely into competition with other users of labor and has changed the service as a result. Moskos calls this change "occupationalization." The attributes of the new occupationalized military are: higher pay for recruits and the resultant increase in the number of junior enlisted personnel who live off-base and have families, more direct compensation (i.e., the choice to receive allowances in cash), some differentiation of pay in consideration of skill, an increased proportion of personnel holding second jobs and the attendant reduced level of commitment to the military, and the increasing reliance on contract labor for some jobs. [Ref. 5: pp.16-17]

One effect of these changes has been increased emphasis on cost-effectiveness. Military managers at the highest levels have begun to pay more attention to the costs of personnel compensation. Enlisted soldiers and sailors may have changed too, such that they are relatively more influenced by money and less by patriotic duty than their counterparts of two decades ago. Lest it be imagined that the government caused all this, it should be pointed out that this societal evolution was well underway by the time the draft ended.[1] It is certainly true that the citizen soldier concept remains important to the AVF. [Ref. 6: p.271]

Many of the studies that will be discussed in this chapter were the result of manpower managers' efforts to learn about economic matters so as to administer personnel resources more efficiently. This economic perspective is new to some, but critical to those who expect success in the competitive market.

2. Theories of Organizational Participation

The problem of organizational participation has interested sociologists and behavioral scientists for years. Organizational participation is defined here to mean an individual's decision to become a member of an organization. Early work by Herbert Simon introduced the idea of an equilibrium between inducements and contributions which was to become important in the development of the literature. [Ref. 7] In this conception, an individual will *contribute* labor to an organization if

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[1] In fact, it could be argued that the societal change helped to cause the end of conscription.

the value of that labor to the individual is less than the *inducements* the organization is able to offer. To the extent that there is freedom to negotiate the participation decision, this same evaluation will take place continuously. For the military application, individuals make these judgments prior to enlisting and near the end of the first and subsequent terms of enlistment.

A similar framework for understanding this sort of decision making is attributed to Thibaut and Kelley. [Ref. 8] In their parlance, comparison is made between a person's current job and the best available alternative. The worker will remain at that job as long as the comparison level, CL,[1] associated with the present position is greater than the CL_{alt} associated with the best alternative. The extent and accuracy of knowledge about alternatives is clearly important here.

For every person voluntarily in the military, it can be said that the perceived level of inducement must have been at or above the amount required at the time the initial enlistment decision was made. The military service must have been perceived as the best available choice. [Ref. 9]

If we knew an individual's perception of the inducements offered by continuing in service compared to those available elsewhere, we could easily predict reenlistment behavior. This logic can be applied just the same whether these inducements are believed to have monetary or non-monetary character. The higher the monetary compensation, the less of other things is required. If pay is low, other positive factors must be present in sufficient measure to induce participation.

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[1] CL is something like the more common "utility" concept.

One attempt to explicate the decision making process that takes place in the minds of people considering separation from an organization segregates factors in four categories. [Ref. 10] These are:

job attributes -- the work and lifestyle,
personal and professional growth potential,
family considerations, and
finances.

This sort of framework is common. The studies of quit behavior in the civilian context provide much of the background for work intended to be relevant to military retention in particular. For example, a 1984 study of production workers in a manufacturing firm models quitting in terms of expected alternative wages, job satisfaction, and the cost of changing jobs. [Ref. 11]

For the purpose of this thesis, the more familiar division of factors into monetary and non-monetary categories is appropriate and will be used for the examinations of the next section.

B. THE INFLUENCE OF SPECIFIC FACTORS

1. <u>Non-Pecuniary Components</u>

Job, personal, and family considerations are obviously important to an individual making a decision about whether to remain in any organization. These factors frequently illustrate a way in which the military service is radically different from its competitors. Sea duty, for example, has been shown to be very meaningful in retention decisions. One pair of researchers even called it "the major non-pecuniary element influencing reenlistment decisions." [Ref. 12: p.26] Warner and Goldberg confirmed their intuition by incorporating the expected amount of second-term sea duty into a quantitative model of first-term reenlistment, and found a statistically significant negative coefficient indicating an elasticity[1] of -0.34. [Ref. 13] The same two expanded their study a year later, classifying Navy ratings into nine categories. They found statistically significant negative relationships in seven of the nine, the central tendency being such that a ten percentage point increase in the incidence of sea-duty decreases first-term reenlistment rate by 1.6 percentage points. [Ref. 14]

People also behave differently depending upon their marital and family status. Strangely, the empirical findings here conflict. One study reviewed the results of previous work and concluded that "the preponderance of evidence is that marriage and children tend to increase the probability of voluntary termination from military service." [Ref. 15: p.58] The reason has to do presumably with the issues of family separation and frequent transfers. The opposite result has been presented by others, however. Work by Chow and Polich based on data from the 1976 Department of Defense Personnel Survey found that reenlistment rates in grades E-3, E-4, and E-5 were consistently higher, by an average of about 50 percent, for those with one or more dependents. [Ref. 16: p.9] Warner and Goldberg postulate that the value of military medical and other benefits is greater to married individuals, and show in their regression model that they are more likely than single members to reenlist. [Ref. 13: p.19] Job stability and security may also play a part. [Ref. 17]

Cultural elements have been largely neglected. An obvious reason is the fact that they are practically impossible to measure quantitatively. But family

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[1] Elasticity is defined as the ratio of percentage changes. Here, -0.34 is the ratio of $\%\Delta$reenlistment/$\%\Delta$sea-duty.

tradition may be very important [Ref. 6]. For instance, Singer and Morton found that retention was higher among personnel who had entered the military from a state other than their birthplace [Ref. 18]. Perhaps such individuals are more accepting not only of moving, but also of being away from family and living a relatively risky life in general.

In the literature on retention and quit behavior, discussions of job satisfaction are ubiquitous. Not surprisingly, there is a clear correlation between job satisfaction and quit behavior [Ref's. 19, 20, and 21]. The factors that contribute to job satisfaction are the same as those previously claimed to influence quit behavior: pay, working conditions, job security, advancement opportunities, dispute resolution mechanisms, and psychological rewards. [Ref. 15: p.35-36]

In the case of the Navy, there are unique rewards. Being able to play with some of the world's most expensive and exotic toys is important for some. Opportunities for travel, possibilities of exciting work, and camaraderie with shipmates are important for many. The responsibility that the military requires its members to take at early stages in their careers is largely unmatched in the private sector. Imagine a nineteen year old man at the reactor control panel on a nuclear-powered aircraft carrier. The training provided by the military is important for almost everyone. People join the armed services for these and many other reasons. Surely these same reasons must also be important when people decide whether to stay.

2. Material Components

a. *Early Findings*

It is widely accepted as well as plausible that organizational participation decisions are influenced mightily by money and by other tangible rewards. Not so predictably, the effects of pay on retention are sometimes complicated. The first complication is the military pay system itself. Because the structure and rules are extraordinarily complex, it is difficult to compare military pay with that of civilian jobs. There are bonuses and special pays associated with sea duty, submarine and flight duty, etc. There are non-taxable allowances for subsistence and quarters if not provided in kind. And medical, dental, and retirement benefits should be included, but are difficult to express in monetary value terms.

There was concern with the relationship of pay to enlistment during the draft era, since not all soldiers and sailors were draftees. Conscription was meant to supply only recruits, not career servicemen. But the situation was different then, since response to pay depended upon the form and magnitude of the draft. One of the first all-volunteer era studies looked at the effects of variable reenlistment bonuses on reenlistment. [Ref. 22] In this study, Kleinman and Shughart followed the path established by earlier work, modeling an individual's decision about continuing military service as a comparison between the present values of expected military earnings and expected earnings as a civilian.

Accounting for discounted present-value is important, because discount rates for young people of military age have been consistently estimated at above 15 percent. Some researchers have arrived at estimates as high as 30 percent [Ref's. 23 and 24]. The monetary value of salary is therefore expected to be much more meaningful to young people than retirement and other benefits which accrue in the future. When older career members are considered, the present value of the legendary military pension is large.

Using data from 1965-1972, Kleinman and Shughart employed linear probability and logit models relating military wages and bonuses to reenlistment rates. Bonuses are variable since the bonus amount is the product of monthly basic pay, period of the new enlistment contract, and the bonus multiple established by the Navy. In this study the multiples range from zero to four. Parameter estimates and bonus elasticities are presented in Table 1.

Table 1

ESTIMATES OF BONUS ELASTICITIES, 1965-1972
(Approximate t-statistic)

	Linear Model		Logit Model	
Interval	α^*	η (elasticity)	α^*	η (elasticity)
FY1965-67	.00174 (7.08)	2.27	.000105 (6.17)	2.20
FY1968-69	.00163 (3.97)	3.62	.000107 (3.25)	3.07
FY1971-72	.00121 (6.39)	4.04	.000115 (6.07)	4.24

SOURCE: Reference 22: p.14
* α is the parameter estimate associated with the present value of military pay variable.

Kleinman and Shughart conclude that a $1000 increase in the bonus will lead to an average increase in reenlistment rate of 1.4 percentage points. An increase by one in the bonus multiple will lead to an average of 0.6 more years of service commitment per affected individual.

The end of conscription presented an opportunity for experimentation. Accompanying the advent of the all-volunteer military was a dramatic increase in pay of junior enlisted personnel effective November, 1971. It ranged from a 32 percent increase for an E-3 to a 9 percent increase for an E-5. Haber and Stewart computed military to civilian wage differentials during the period 1971-

72. [Ref. 25] They determined pay elasticities as shown in Table 2. Note that there were significant differences between ratings where personnel could earn a Variable Reenlistment Bonus (VRB) and those where they could not.

Table 2

ESTIMATES OF PAY ELASTICITIES, 1971-1972

	Ratings with no VRB[c]			Ratings with VRB		
	E-3	E-4	E-5	E-3	E-4	E-5
Craftsmen	4.49	3.10	3.50	2.95	3.30	1.93
Clerical	4.53	7.16	1.19	*b*	2.62	-4.47
Service	*a*	-1.07	0.74	*b*	*b*	*b*
Miscellaneous	3.17	1.90	1.58	4.48	3.23	1.94

SOURCE: Reference 25: p.13
a fewer than 100 observations.
b no eligible ratings in this category
c VRB was the forerunner to the present Selective Reenlistment Bonus system.

An important aspect omitted by these two studies is the effect of availability or non-availability of civilian jobs on quit behavior. Military pay and bonuses might be less important when economic conditions outside are poor; if civilian jobs are plentiful, however, military pay comparability will be more important. As just one example, Lippman and McCall found that quit rates in manufacturing were strongly related to the "business cycle." In the civilian sector, they detected more quits and job volatility in better times. [Ref. 26] Of course, enlisted men's ability to respond to such fluctuations is limited.

A 1977 study by Enns used cross-sectional data from fiscal years 1971-74 and modelled the reenlistment rate as a function of pay and bonuses, controlling for demographics such as race, education level, mental aptitude, entry age and dependents. [Ref. 27] He found pay elasticities of 2.10 (Army), 2.58 (Navy) and 3.40 (Air Force). Using only Army data, and assuming installment bonus payments, he estimated the bonus elasticity at 2.0. Enns attempted to show the existence of occupational differences, but was not able to do so with sufficient statistical confidence.

Among the first to consider unemployment quantitatively were Cohen and Reedy. [Ref. 28] In addition to using the national average rate for 20-24 year olds and for the population in general, this study used various lagged values as well as rates by geographic region. The results showed dynamics to be important--a rapidly changing unemployment rate had a different effect than a stable situation at the same rate. If the unemployment rate has recently decreased to a current relatively low value, for example, they found that reenlistment rate would be higher, as if the unemployment rate were still at a high level. Additionally, they found indications that the amount of doubt about the future, higher at moderate unemployment rates, makes a difference. Apparently when unemployment is at a high level, for example, people believe it will decrease. The longer it stays high, the greater the confidence that it will soon be lower.

Occupational differences were apparent in this data. While the occupationally differentiated unemployment rates did not perform better than aggregates, some occupational categories were more affected by the aggregated rates than others. The most sensitive was the electrical and electronics category.

A 1979 effort by Warner and Simon used post-draft data exclusively, attempting to determine the effects of pay on both first and second-term retention decisions. [Ref. 29] They separated Navy ratings into sixteen occupational areas.

The Annualized Cost of Leaving (ACOL) model, developed by Warner, was used.[1] This model predicts reenlistment based upon A_n, the maximum annualized cost of leaving. For example, suppose a person believes he could make $80,000 in today's dollars over the next four years in a civilian job. If his expected military pay is valued at $90,000 he has a total present value cost of leaving of $10,000. He will reenlist only if his taste for civilian life ($-\gamma$), which can include many things, exceeds this $10,000 monetary cost of leaving. The retention rate should be the proportion of people for whom $-\gamma$ is greater than A_n.

With this formulation, we can make predictions about reenlistment. It is perhaps more convenient to assume that civilian earnings exceed military earnings, so that the cost of leaving A_n is negative. Thus a more appropriate expression for the reenlistment probability is $r = Pr(\gamma > -A_n)$. If A_n is calculated, then the expected value of r can be determined by assuming a probability distribution for γ. The time horizon is key in the application of this model. An individual can be thought of as calculating costs A_n for all possible future times, $n=1,2,\ldots,T$. Only one of these needs to exceed the taste for civilian life γ in order for the individual to benefit from staying.

In the study by Warner and Simon, a normal distribution of γ is assumed and the probit specification results. The analysis was able to demonstrate a strong positive relationship between reenlistment and military pay. In addition, there were occupational group differences. The parameter estimates were highest for white-collar ratings and for those where working conditions in the Navy are not drastically different from comparable jobs in the civilian sector. The ratings

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[1] The following discussion of the model closely parallels that in reference 11.

which have the most arduous working conditions had the lowest parameter estimates, meaning they are least responsive to pay changes. Pay elasticities found by this study range from about 1.0 to 3.0. An increase in the bonus multiple by one was found to result in a 2 to 5 percentage point improvement in reenlistment rate. An interesting complication is introduced by these authors. It is likely that first-term reenlistment bonuses will decrease the average value of γ in the second term population due to self selection. Therefore, the second-term reenlistment rate will suffer in comparison to what it would have been if there were no first-term bonus.

b. Recent Findings

In 1976 the Department of Defense conducted an exhaustive survey of officers and enlisted personnel. Retention was a principal issue. In 1980, Chow and Polich matched actual reenlistment outcomes of survey respondents using social security numbers provided by Defense Manpower Data Center (DMDC) to allow estimation of models of reenlistment intention and behavior. [Ref. 16] They used a logit specification and confirmed the importance of pay and reenlistment bonuses. Interestingly, they also uncovered consistent underestimation of total military compensation by members. This misperception ranged from 62 percent to 90 percent of actual RMC.[1] The difference between actual and perceived RMC was found to be negatively related to reenlistment in a significant way, i.e., the larger the difference, the lower the reenlistment probability.

In 1981 the first of several important studies by John Warner and Matthew Goldberg was published [Ref. 12]. Its purpose was to determine the effect

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[1] Regular Military Compensation is basic pay plus allowances plus the tax advantage of allowances.

of sea-duty on reenlistment rate using the ACOL framework. Occupations were segregated into sixteen categories to allow for variation in sea duty [Ref. 29]. They used time series data from fiscal years 1974-78 and found pay elasticities on the order of 2.0, confirming previous results.

Goldberg and Warner followed this effort in 1982 with what might be called a landmark publication. [Ref. 13] This was the first study to consider extension as a third option to reenlistment and separation from the service. It was also the first to effectively model the retention decision incorporating all of the significant variables: pay, bonuses, and civilian sector economic conditions. In this work, the sixteen occupational categories were reduced to 9. Using data from 1974 to 1980, they employed a utility maximization framework where the utilities of reenlistment, extension, and leaving the service, respectively, are:

$$V_R = M_R + \alpha_R \mathbf{Z} + u_R$$

$$V_E = M_E + \alpha_E \mathbf{Z} + u_E$$

$$V_L = C + \alpha_L \mathbf{Z} + u_L$$

where M = annualized military pay over the appropriate time horizon
C = annualized civilian pay
$\alpha\mathbf{Z}$ = vector of monetary value of "taste" factors
u = random error terms

Note that for reenlistment the value of M will include whatever bonus amount applies, while those extending do not earn a bonus. This construction leads to a logit model specified by the following two log-odds equations expressing probabilities of reenlistment, extension, and leaving.

$$ln\,(P_E/P_L) = (\beta_E - \beta_L) + (\alpha_E - \alpha_L)\,\mathbf{Z} + \beta(M_E - C) + \varepsilon_1$$

$$ln\,(P_R/P_L) = (\beta_R - \beta_L) + (\alpha_R - \alpha_L)\,\mathbf{Z} + \beta(M_R - C) + \varepsilon_2$$

This study included as explanatory variables the unemployment rate, demographic dummies, and the expected amount of second term sea-duty. Pay, unemployment, and sea-duty parameter estimates are presented in Table 3.

Table 3

PARAMETER ESTIMATES FOR PAY, UNEMPLOYMENT, AND SEA-DUTY
Goldberg and Warner, 1982

Occupational Category	Extension			Reenlistment			Pay
	M_E - C	U rate	Sea-duty	M_R - C	U rate	Sea-duty	Elasticity
Non-elect[a]	.000183	-0.105	0.393	.000183	0.213	-1.794	1.89
Electronics	.000205	0.065	0.414	.000205	0.392	-1.121	2.02
Administrative	.000239	-1.33	-1.732	.000239	0.150	-3.426	1.78

SOURCE: Reference 13
a technical non-electronic ratings, most of which are seagoing.

Goldberg expanded upon this work in 1985 with the benefit of more data, from fiscal years 1977-84. [Ref. 30] This study used the same logit model as the 1982 effort, but took advantage of the greater variations in unemployment rate that occurred in the early eighties. This time a 10 percent discount rate was assumed. Controlling for race and education, he used the generalized least squares regression technique to estimate the parameters associated with pay and unemployment variables. These parameters were all found to be positive and statistically significant. Pay elasticities were, in general, three to five times as large as unemployment elasticities; implying that a 10 percent decrease in the unemployment rate can be offset by a 2 to 4 percent increase in military pay. The elasticities of total retention rate with respect to pay alone were on the order of 2.0 for all rating categories, as had been previously determined. Goldberg concludes with the following comment:

> While unemployment is an important determinant of retention, it is of only secondary importance when compared to military pay. Military pay can be used not only to offset changes in unemployment from year to year, but also to control differences in retention rates across ratings through reenlistment bonuses. Flexible, targeted pays such as reenlistment bonuses are the Navy's most potent tool for controlling retention rates. [Ref. 30: p.10]

Two other works followed in the footsteps of Warner and Goldberg. These were done in 1985 by Hosek and Peterson [Ref. 31] and in 1987 by Cymrot [Ref. 32]. The first of these focused on bonuses and performed a comparison of lump-sum and installment payment methods, facilitated by the policy change in 1979 which replaced installment by lump-sum payments. They also succeeded in accounting for extension as a decision distinct from reenlistment or separation. Lump-sum bonuses were shown to be more effective in increasing reenlistment. In addition, bonuses were shown to be preferable to general pay increases to combat the effect on retention of lowering civilian unemployment. Tables 4 and 5 below demonstrate this point using their model estimates to forecast response of personnel to assumed changes in unemployment from 10 to 8 percent.

Table 4

ADJUSTING PAY TO OFFSET LOWER UNEMPLOYMENT IN THE FIRST TERM

	Unemployment 10%	8%	Pay Increase 2.5 points
Reenlistment	17	14	15
Extension	10	11	12
Retention	27	25	27

SOURCE: Reference 31

Table 5

ADJUSTING BONUS LEVELS TO OFFSET LOWER UNEMPLOYMENT IN THE FIRST TERM

	Unemployment 10%	8%	Bonus Increase[a] $2230
Reenlistment	17	14	17
Extension	10	11	10
Retention	27	25	27

SOURCE: Reference 31
a In 1976 dollars.

These tables show that while both pay increases and bonus increases can recover the original 27 percent retention rate, the pay increase does so by increasing extensions at the expense of reenlistments. This result is even more pronounced at the second term. The explanation is that during poor economic conditions, many people simply extend to wait for things to get better. The impact of this difference on total obligated manyears is clear.

Cymrot's research looked at the Marine Corps' SRB program. He used logit ACOL and reconfirmed the significance of pay, bonuses, and unemployment. The bonus was again determined to be the most important of factors.

As the use of targeted bonuses has become prevalent, attention has been drawn to the irrationality of the military pay system. The case was made as early as 1981 for a differently managed pay system which would establish compensation based on skill and duties. [Ref. 33] Recognizing that the present system pays people differentially by skill through the use of bonuses, Binkin asserts that what is good by evolution would be better by design. He presents a strong argument for eliminating the traditional linkage between pay and rank. Although this is a somewhat extreme view, it highlights the importance of bonuses one of the only flexible aspects of the present military pay structure.

C. SUMMARY

Economic theory indicates that if participation is a function of pay, shortages will develop where pay is insufficient. Given the relatively invariant military pay scales, retention problems should therefore occur among those personnel where alternatives to the Navy are most attractive. This is the reason for the attention here to personnel in high skill occupations doing jobs which are the most arduous. It is likely that these people will have the most to gain by leaving the service since they can command better wages in the private sector than their less skilled counterparts. Similarly, for demanding assignments, less monetary difference between the military and the nearest civilian alternative is necessary to induce a person to quit.

Targeted bonuses for reenlistment, as well as sea-pay and other special duty pays, mitigate this differential but do not eliminate it completely.

Several of the studies cited confirm that significant differences exist in the behavior of various occupational groups in the military. The basis for the explorations of the following section is the expectation that different groups of people should respond differently to civilian labor market factors, including pay comparability, depending upon the applicability of their skills to civilian firms.

III. DATA AND METHODOLOGY

A. THE DATA

1. Sources

Two types of data are needed to conduct the desired analysis: first, information about military pay, civilian pay, and economic conditions; second, information about the actual behavior of nuclear-trained enlisted men.

The first is available largely from public sources. *Navy Times* publishes military pay tables every year when raises are enacted by Congress. These include basic pay and basic allowances for quarters and subsistence. Other elements of military compensation present more of a problem. Sea pay and selective reenlistment bonus (SRB) multiples for the time period 1975-1984 were obtained from sources at the Center for Naval Analyses (CNA). More recent SRB multiples were obtained from the Office of the Chief of Naval Operations (OP131 and OP136); sea pay rates were taken from the Uniformed Services Almanac. Economic variables such as unemployment rates and average weekly earnings were extracted from monthly publications of the Bureau of Labor Statistics (BLS).

Organization Resources Counselors, Inc. (ORC) was able to provide crucial information concerning employment and wages from its annual surveys of the civilian nuclear industry. The average monthly salaries, based upon 40 hours per week, and the total number of positions were reported for 9 occupational categories. Not only are these categories comparable to nuclear Navy occupations, they are also predominantly filled by nuclear Navy veterans. These data were available from 1977 to the present.

Finally, the Defense Manpower Data Center (DMDC) constructed tapes from their enlisted master file for all members having the relevant Navy Enlisted Classifications (NECs) with years of service between 4 and 9 years; records were extracted annually as of 30 September from 1975 to 1987. (See Table 6.)

The method to be employed in this thesis is based on examination every September of the members who have less than about 13 months remaining in their enlistment contract. Screening of the following year's file allows determination of the retention choice made by each of these members. If they are still in the Navy, they will appear in the next year's data file with a new date of contract expiration. If they do not appear, it can be inferred that they chose not to continue in the service and were separated from the Navy.

Table 6

DESCRIPTION AND DISTRIBUTION OF NECS[a]

NEC	Corresponding Rating	Supervisory[b]	Percent
3353	Electrician's Mate (EM)	No	17.9
3354	Electronics Technician (ET)	No	21.9
3355	Machinist's Mate (MM)	No	21.9
3356	Machinist's Mate (ELT)[c]	No	12.0
3363	Electrician's Mate	Yes	6.1
3364	Electronics Technician	Yes	7.7
3365	Machinist's Mate	Yes	7.6
3366	Machinist's Mate (ELT)	Yes	4.9

a During part of this period, there were also some Interior Communications Electricians (ICs) in the nuclear field, performing the same jobs as Electrician's Mates. Exclusion of the 2 NECs corresponding to nuclear trained ICs was an oversight by the author.

b The supervisory NEC is assigned to personnel E-6 and above with over 6 years of service and Commanding Officer's recommendation. Accompanying this designation are supervisory watch duties and proficiency pay. SRB multiples are also frequently higher for those with the supervisory NEC.

c Engineering Laboratory Technicians (ELTs) receive training in chemical and radiological controls in addition to the normal nuclear Machinist's Mate training.

2. Selective Reenlistment Bonuses

Retention problems in this sector of the Navy are well-known. One attempt to increase reenlistments is the Selective Reenlistment Bonus (SRB) program. Members who reenlist for three or more years are eligible for a cash bonus equal to their monthly basic pay multiplied by the product of the number of years obligated and a multiple based upon their NEC. Table 7 shows the high SRB multiples that have existed almost since the program's inception. In addition, the program consists of two statutory caps, one on the total amount of each bonus, and another lower cap that can be exceeded by only 10 percent of the bonuses paid. Nuclear trained personnel have consistently taken up a majority of the 10 percent that can be above the lower cap.

Table 7

SRB MULTIPLES SINCE 1976[a]

Fiscal Year	SRB Multiple Zone A[b]	SRB Multiple Zone B[b]	90% Cap	Absolute Cap
1976-80	6.0	6.0	$15,000	$15,000
1981	6.0	6.0	$16,000	$20,000
1982-83	5.0	6.0	$16,000	$20,000
1984	5.0	4.8	$16,000	$20,000
1985	4.5	4.5	$20,000	$30,000
1986	4.0	5.0	$20,000	$30,000
1987	4.0	5.0	$20,000	$30,000

a When multiples differed among NECs table entries are weighted averages.
b Zone A is for reenlistments prior to the sixth year of service. Zone B is from six to ten years of service.

SRB rates or multiples have been used as explanatory variables in reenlistment formulations of previous studies. There are simultaneity problems with this approach, since multiples are determined to some extent by personnel shortages. Thus retention rates are a factor as well. For this sector of the Navy, there is little variation in the multiples so the bonus is not used explicitly in any model. Bonuses will be incorporated in calculations of military pay. Since multiples are so high, the caps are significant. Figure 1 shows the effect of the statutory cap on a hypothetical 48 month reenlistment of a second-class petty officer (pay grade E-5) with six to eight years of service. The figure shows the bonus amounts that such an individual could have earned for a 4 year reenlistment had there been no cap. For most of the period covered, such an individual would not have received that amount due to the cap. Until the cap increased to $30,000 in 1985 there was no incentive to reenlist for as much as 48 months, since the cap could be reached by a shorter term of reenlistment.

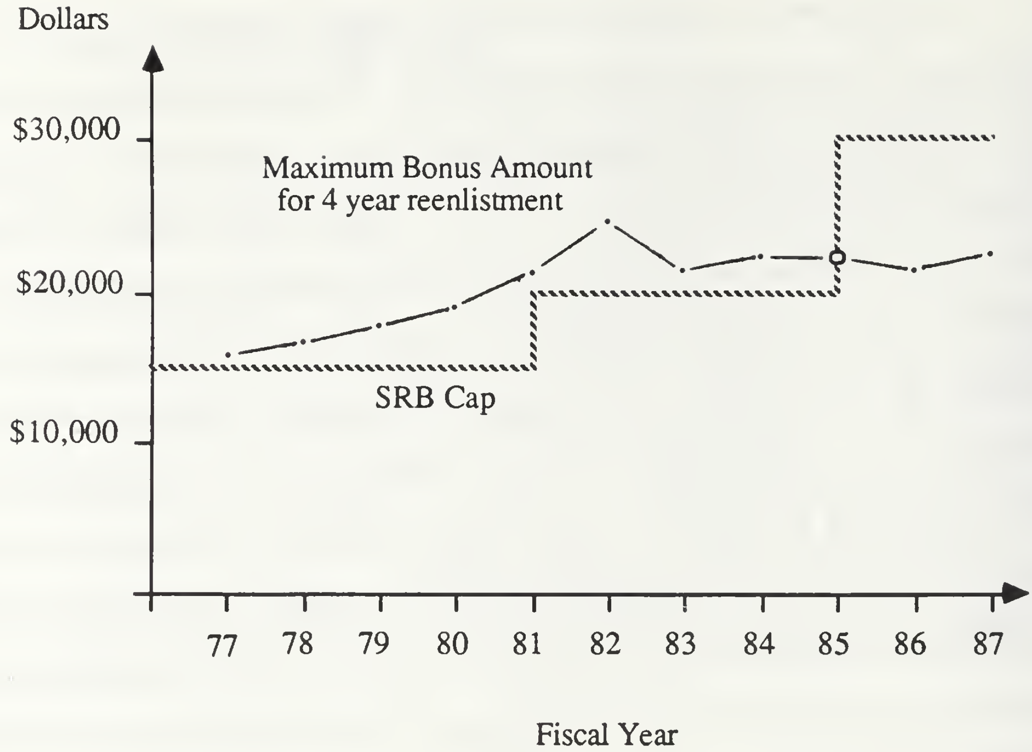

Figure 1. The Effect of SRB Caps

Figure 2 shows how the number of months necessary to reach the cap declines as basic pay increases, and how the average amount of contracted service increases when the cap is raised. For the first few years, the number of months for which a member had to reenlist to reach the cap decreased. During this period the multiples were constant and basic pay was rising slowly. After 1981, changes in the cap, dramatic changes in basic pay, and changes in multiples caused erratic variation in months required to reach the cap. Through 1984 the average length of a reenlistment contract was about equal to the length required to reach the cap, indicating that there were very few, if any, contracts for greater than this amount of time. This is clear because a person must reenlist for at least three years in order to qualify for an SRB.

After the cap was raised to $30,000 in 1985, the contract length required to reach the cap increased substantially. The average reenlistment also increased, to the point where a typical contract was for almost 4.5 years.

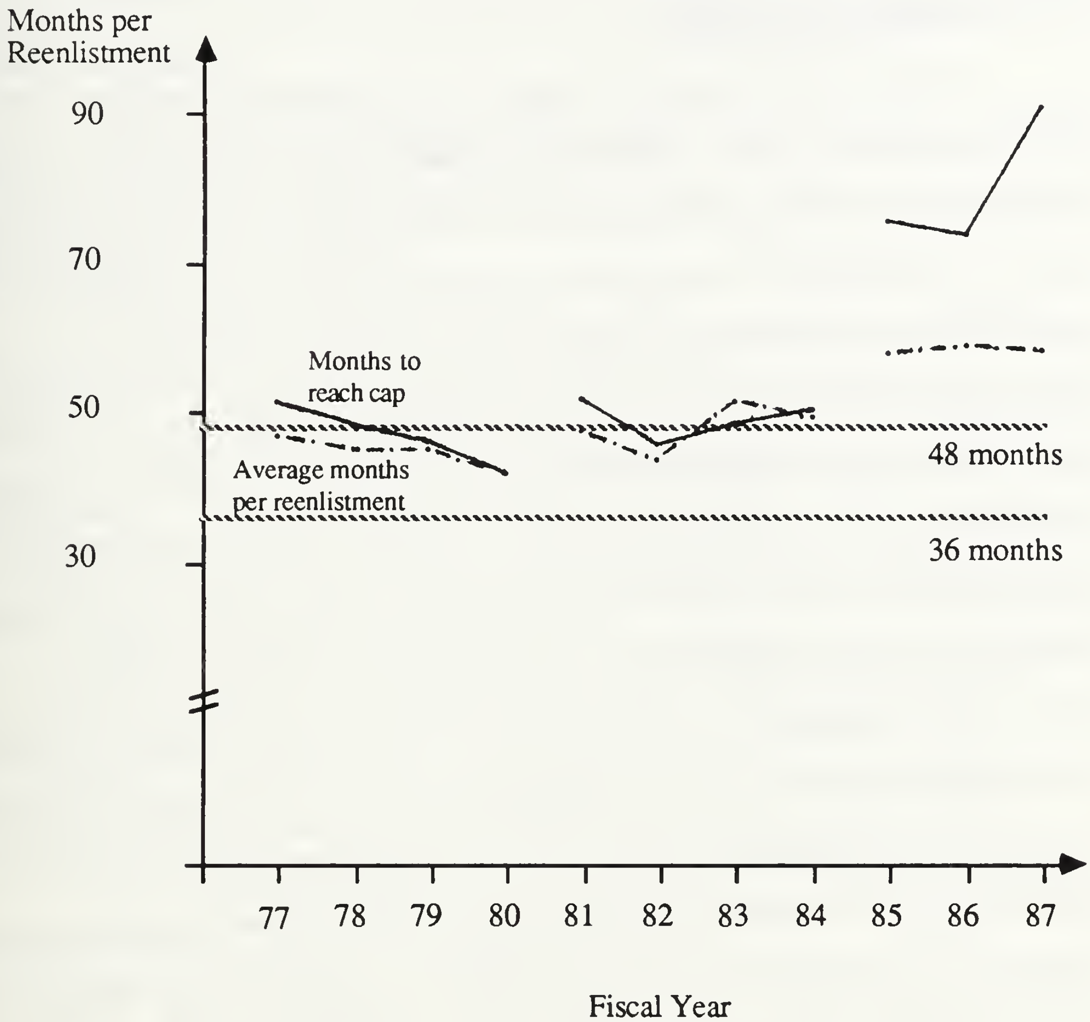

Figure 2. Months to Maximize SRB and Months Obligated per Reenlistment

At times, usually at the end of a fiscal year, and sometimes at the beginning if there is a delay in enactment of the Defense Appropriation, the SRB program has been unfunded. These gaps in coverage have never lasted long, so there is probably no effect on reenlistment behavior. There is probably a significant effect on extensions, however. Personnel who desire to reenlist while the program is unfunded will extend for a short period of time until they can receive an SRB.

3. Data Set Construction

The data for this thesis consists of two components. The first of these is the economic and pay data. Thirteen observations of all the variables assembled were read into a file, one per year for 1975-1987 inclusive. A reference date of 30 September was chosen to correspond to the date of sampling of the DMDC enlisted master file. BLS data from the September issues of *Employment and Earnings* (August estimates) were used, along with March issues for possible lagging of unemployment rates as Cohen and Reedy have done [Ref. 28]. ORC survey data for 19xx was used for the September 19xx entry, since the survey is representative of pay existing during the calendar year of its date. It is therefore represents the civilian pay alternatives of those who are candidates in the 19xx data file.

This methodology is counter to the ACOL concept, introduced in chapter two. Rather than assuming forward thinking behavior, it is proposed here that pay comparisons made during the year before the reenlistment decision is required are more relevant. If a member must make a choice about continuing in service a year from now, he will investigate the job market now, and make his decision well before the actual expiration date of his contract. Rather than evaluating present value of future earnings, it is assumed that the member only considers current conditions. It is plausible that the best estimate of pay in the near future is pay today.

Military basic pay, allowances, and SRB multiples used in the 19xx file were those in effect during the 19xx fiscal year. This produces direct comparability to the civilian pay data described above. Next year's pay is typically only a marginal increase from this year's pay and the increases being considered by Congress are widely known during the summer while budget bills are being debated. Members expect future earnings comparisons to be roughly equivalent to today's comparisons.

SRB multiples also typically undergo only marginal changes. And for the group considered here, SRB multiples were consistently at the maximum until the last few periods of observation.

The second component making up the data set came from Defense Manpower Data Center. The DMDC data was segregated into thirteen files, one for each year of observation. Members with a date of contract expiration (ETS) greater than 13 months from 30 September were deleted. Thirteen months was chosen to correspond roughly to an annual cycle, while allowing the inclusion of choices made in advance of the actual date of contract expiration. The choice of a time frame is a tradeoff. If a shorter time period is chosen, then non-candidates will reenlist and not be counted. If a longer time period is chosen, then some will be included who do not make a decision, falsely reducing the calculated rates.

Each of these candidate files was merged with the entire file from the subsequent year by matching social security numbers, creating a new file for each of 12 years. These matched files allowed analysis of retention behavior of the candidates. If a candidate appeared in the following year's file with the same date of contract expiration (NETS=ETS)[1], then either the member had not made a reenlistment choice, or whatever choice he made had not been entered into

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[1] NETS is the value of ETS for a member in the second year's file.

DMDC's file by 30 September of that year. Because their decisions could not be determined readily, these members were deleted from further consideration, leaving a net number of observations for that year. See Table 8. There is no reason to believe that these people behave differently than those in the sample.

Reenlistments frequently occur several months early, while those who choose to separate will reveal their choice on the ETS date. The method used here is slightly flawed in that it will not detect some who reenlist early. For example, if a member's ETS date is in November of the second year of a pair and he reenlists in August, he will not be in the candidate data set of either year and his choice will not be counted.

In addition, many nuclear trained men enter the Navy with a four or six year term that is extended automatically by two years when they finish nuclear propulsion training. It will appear by the construction of the candidate variable that these men have a reenlistment choice to make, while they actually do not. This problem was solved as follows. If a candidate appeared in the second year of the pair with an ETS date *exactly* two years from the old ETS date, that member was deleted from the candidate set. Some actual voluntary two-year extensions may have been deleted improperly. There are only a very few observations of NETS-ETS that exceed two years, though, so the number of lost observations should be small. The numbers of observations in these candidate data sets are presented in Table 8.

Table 8

NUMBER OF OBSERVATIONS IN DMDC CANDIDATE DATA SETS

Year	Number	ETS = NETS	Net	Auto ext's	True candidates
1976	1164	89	1075	2	1073
1977	1317	91	1226	1	1225
1978	1155	84	1071	48	1023
1979	1089	31	1058	81	977
1980	1176	100	1076	80	996
1981	1118	127	991	127	864
1982	1378	152	1226	133	1093
1983	1255	33	1222	131	1091
1984	1277	145	1132	104	1028
1985	1418	119	1299	95	1204
1986	1501	152	1349	91	1258
TOTAL	13848	1123	12725	893	11832[a]

a. There were two cases of missing data, reducing the actual sample size to 11830 observations.

4. Characteristics of the Cohorts

Data provided by DMDC included the following information about each member.

Table 9

DMDC DATA

Variable Name	Description
SSN	Social Security Number, used to match members of subsequent annual files
TAFMS	Total active federal military service (months)
ED	Education level
AFQT	Armed Forces Qualification Test score
PYGD	Pay grade
RACE	Race (white, non-white)
STAT	Marital status
DEP	Number of dependents
MCAT	Mental category (based upon AFQT score)
AGE	Age at entry into service
PNEC	Primary NEC
ETS	Expiration of present enlistment contract
DOR	Date of present rank
DOLE	Date of latest enlistment
HOR	Home of record

A number of remarks can be made concerning trends revealed by the DMDC data sets. Some of these confirm findings of previous researchers, while some draw attention to ways in which these men differ from the average sailor.

First, by the available measures, these men are among the smartest enlisted personnel in the Navy. Half of them scored in the 80th percentile or above on the Armed Forces Qualification Test (AFQT) upon entry into the service. This significantly exceeds, for example, that of the average Navy enlistee in fiscal year 1986 who scored in the 59.7th percentile [Ref.34]. Practically all are at least high school graduates, and a significant number have some college experience. In 1975, 7.6 percent of the 3767 men in the 30 September file had completed at least one year of college. By 1987, this increased to almost 10 percent.

The average candidate is about 24.5 years old. Over 95 percent are white, and about 60 percent are married. The seniority distribution changed noticeably over the 13 years. The "aging" of the force, which has been discussed in popular literature, is illustrated by these data. The median time in service grew from 61 months in 1975 to 69 months in 1987, an increase of over 10 percent.

B. METHODOLOGY

1. Models

The data is arranged in two forms, called model A and model B. Model A is an individual level model consisting of the 11830 candidates. For each member, the choice of reenlistment, extension, or separation is known. This will be the dependent variable for the econometric analysis of the next chapter. Model B follows the methodology used by Goldberg and Warner [Ref. 13] and Hosek and Peterson [Ref. 31]. It consists of 44 cells: 4 NEC categories by 11 fiscal years, 1977-1987. For each cell a reenlistment rate and an extension rate are calculated and used as dependent variables for analysis. Originally it was intended to include two additional categories, separating people either by length of service or using the supervisory NEC, since reenlistment rates for those past the six year point should be significantly different than for those in the first term. This would have increased the number of observations to 88, but was found to be impractical. The small cell sizes that resulted in a few cases produced unreliable reenlistment and extension rates.

2. Calculation of Reenlistment and Retention Rates

Reenlistment for both models is defined as an increase in obligated service over the previous ETS date of greater than three years. Those who contracted for shorter amounts of additional obligated service are considered extenders. The three year period was chosen to correspond to the length of service commitment required to earn a reenlistment bonus.

The data analysis was done on the mainframe computer at the Naval Postgraduate School using SAS programming. The reader can refer to Appendix A for program steps used to set up and analyze the data.

Reenlistment rates for this group are relatively low for the entire period of the analysis. Tables 10 and 11 show the findings of this study and provides comparisons with two reports published by the Center for Naval Analyses (CNA) using similar methodology. Figure 3 depicts reenlistment rates graphically. The Navy-wide numbers are consistently better than those in the nuclear field.

Table 10

REENLISTMENT RATES
Comparison to CNA Studies

Fiscal Year	Reenlistment Rate	December 82[a] (ET)	December 82[a] (MM,EM)	July 85[b] All Ratings
1977	9.4%	16%	22%	19.6%
1978	7.1	16	19	17.4
1979	8.0	11	15	14.4
1980	9.5	15	15	15.1
1981	7.7			18.4
1982	8.0			22.4
1983	13.2			27.1
1984	16.0			27.5
1985	16.6			
1986	12.7			
1987	11.1			
AVERAGE	10.9%			

a Reference 13.
b Reference 30.

Table 11

EXTENSION RATES
Comparison to CNA Studies

Fiscal Year	Reenlistment Rate	December 82[a] (ET)	December 82[a] (MM,EM)	July 85[b] All Ratings
1977	2.5%	8%	7%	7.9%
1978	1.6	8	7	8.7
1979	6.6	10	10	10.5
1980	6.8	13	9	11.6
1981	3.6			14.5
1982	4.5			17.3
1983	4.7			20.1
1984	5.4			17.5
1985	5.2			
1986	6.2			
1987	7.2			
AVERAGE	4.9%			

a Reference 13.
b Reference 30.

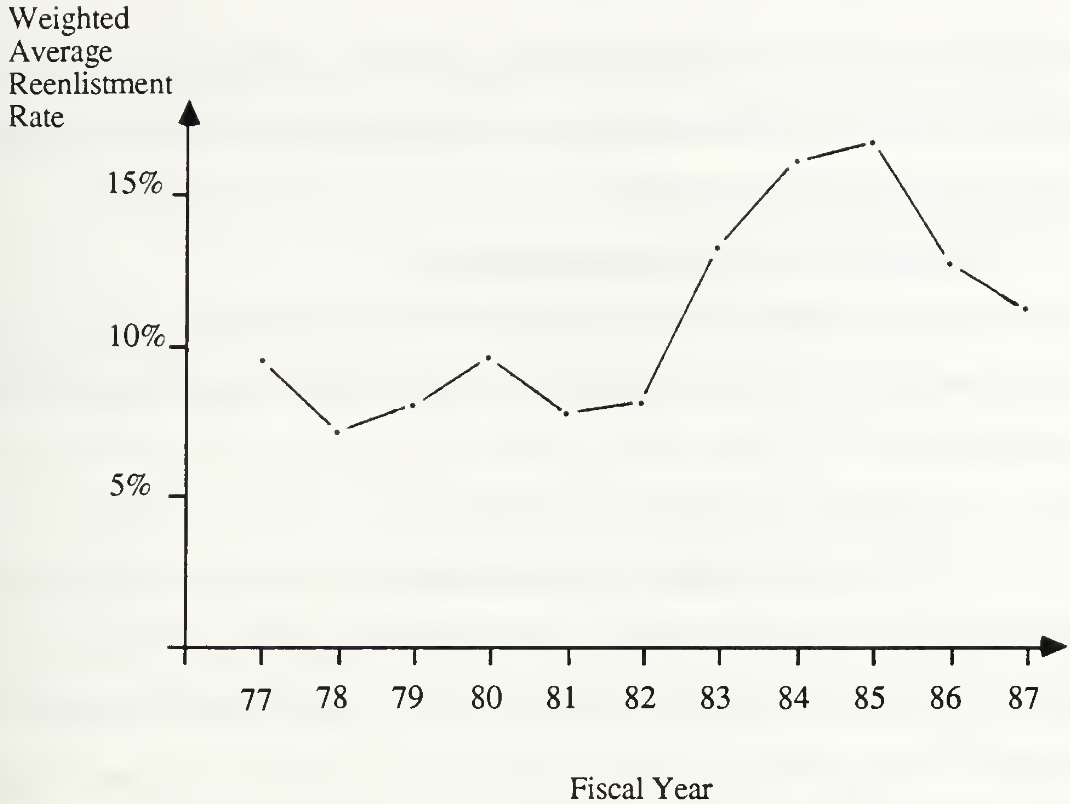

Figure 3. Reenlistment Rates, 1977-1987

Reenlistment is more important than extension for Navy retention. Extensions are usually short term, averaging about six months, while reenlistments obligate the member for significantly longer periods of time. Once a member is retained to about the ten year point, retirement benefits available at twenty years of service become very important. Retention is not so much of a problem after that. In addition to being relatively inconsequential to turnover costs, extensions can be caused by many things. They are seasonal, since many people prefer to change jobs during the summer months. Decisions to extend can be related to a ship's operating schedule and family considerations, and even to reenlistment considerations. Some people extend because they are considering reenlistment; some extend because they aren't, and want to wait for a good civilian job before separating from the service.

Perhaps a man who is expecting a promotion will extend so that he can earn a larger bonus by reenlisting after the promotion. Partially because of these complications, this thesis focuses on reenlistment.

3. Calculation of Military and Civilian Pay

Some assumptions are needed to allow convenient estimation of the pay calculations these members are presumed to make. These are discussed in the next two sections.

a. *Model A, Pooled Individual Data*

The military basic pay system establishes salary by rank and time in service. Three categories of basic pay are used for this thesis: E-5 with over six years of service, E-6 with over six years of service, and E-6 with over eight years of service. Since well over 90% of the members with between 6 and 8 years of service are E-5 and E-6, this split into three categories is deemed appropriate. These are predominantly the men making reenlistment decisions. All candidates earning less than or equal to an E-5 with over six years of service are assigned a value of basic pay as if they were E-5 over six. Those few who earn more than an E-6 over eight are assigned a value of basic pay as if they were E-6 over eight. Less than five percent of the candidates had to be assigned improper pay values in this fashion. Values for Basic Allowance for Quarters (BAQ) are assigned in the same way. Values for sea pay are assigned based on pay grade and on an estimate of time at sea equal to years of service minus two. This is because a typical nuclear trained man probably has at least 18 months of total service by the time he reports to a ship. A member's potential SRB is calculated based upon his basic pay and the current multiple. Due to the proximity to the statutory SRB cap, only a three year reenlistment is assumed. Prorating the SRB amount over the 36 month term of reenlistment[1], the total military pay of each member is defined as:

$$MILPAY = BASEPAY + BAQ + SEAPAY + SRB/36$$

Inclusion of BAQ will lead to overestimation of military pay for some members who do not receive that allowance. There is also an allowance for subsistence (BAS) and a variable housing allowance (VHA) in some areas which some members receive. In general, military pay is probably underestimated for married personnel, and overestimated for single personnel due to these simplifications. Omission of submarine pay and proficiency pay will also lead to underestimation of military pay in some cases. The data did not provide a method of segregating the submarine-qualified personnel from those assigned to surface ships.

Pay in the civilian nuclear industry depends upon occupation. Nine civilian nuclear occupations are closely comparable to those in the nuclear Navy and are predominantly filled by Navy veterans. The occupations and their descriptions are contained in Table 12.

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1 The method of SRB payment varied over the period covered by this research. Until April 1979 it was paid in equal annual installments. Lump sum payments were from that date until January 1982, when the present system was adopted. Now the member receives 50% at reenlistment and the remainder in annual installments. The calculation above was used regardless of the method in effect at the time, which amounts to assuming a zero discount rate. Although this approach is not vary satisfactory from an analytical standpoint, it greatly simplified the calculations.

Table 12

COMPARABLE NUCLEAR INDUSTRY OCCUPATIONS

Code	Title	Filled By
E331	Control Operator	ET, EM
E334	Auxiliary Equipment Operator	MM
E343	Health Physicist	ELT
E346	Chemical and Radiation Control Supervisor	ELT
E349	Chemical Technician	ELT
E352	Radiation Control Technician	ELT
E390	Instrumentation and Control Technician	ET
E408	Mechanic	MM
E414	Electrician	EM

SOURCE: Reference 35

Not all of these are strictly entry level positions, particularly the control operator and C/RC supervisor. However, these are positions that a nuclear Navy veteran can reasonably be expected to fill after a relatively short period of training and time on the job.

The expected civilian pay of a member is calculated as the weighted average monthly pay of the occupations for which he qualifies. Weights are assigned based on the number of positions reported for each occupation in the year. Assumptions had to be made here. First, for the last several years a premium has been paid to control operators when they earn a Nuclear Regulatory Commission license. Data on the amount of this premium is available only since 1981. Since that time, the average premium has fluctuated from about 8 percent of monthly pay to about 12 percent, with a generally increasing trend. Most of this change is due to the increasing prevalence of companies offering the premium. To simplify the calculations required for this study, a premium of 10 percent is assumed for the entire time period.

The second assumption concerns the number of hours worked. The average monthly salary reported is based upon a 40 hour week. In this industry, substantial overtime hours almost always prevail. It is most common among watchstanders (E331 in particular) but occurs in practically all occupations. The amount of overtime increases during some phases of construction and during shutdowns. Based on data from a single company, overtime is assumed to augment average monthly salary by factors of 1.3 for MMs, 1.4 for EMs and ELTs, and 1.5 for ETs.

Ratios of military to civilian pay calculated by this method have a mean of 0.515 and a standard deviation of 0.082, and range from a minimum of 0.369 to a maximum of 0.762. Sensitivity of the results to these assumptions is evaluated in the next chapter.

b. Model B, Grouped Data

Since the civilian pay data varies only by occupation and time, the grouped data model can draw on the same calculation methods described for the first model. But each cell will contain military members with different ranks and years of service. Due to this problem, basic pay, BAQ, and SRB multiples for this model are calculated using a weighted averaging technique. There was some variation in rank and years of service distributions during this time period. On average, about 63 percent of all candidates have less than 6 years of service. The 63 percent figure was used to weight the SRB multiple using zone A and zone B multiples. It was also used, along with the fact that about 79 percent of those under 6 years of service were E-5s, to calculate a weighted average of basic pay and BAQ. Separate weighting could have been applied to each cell, but was not done in the interest of simplicity. This method does not amount to a large problem. For example, the weighted average never differs from the highest and lowest possible salaries by more than about $80.

Weighted average pay ratios determined by these calculations are shown in figures 4 and 5 below.

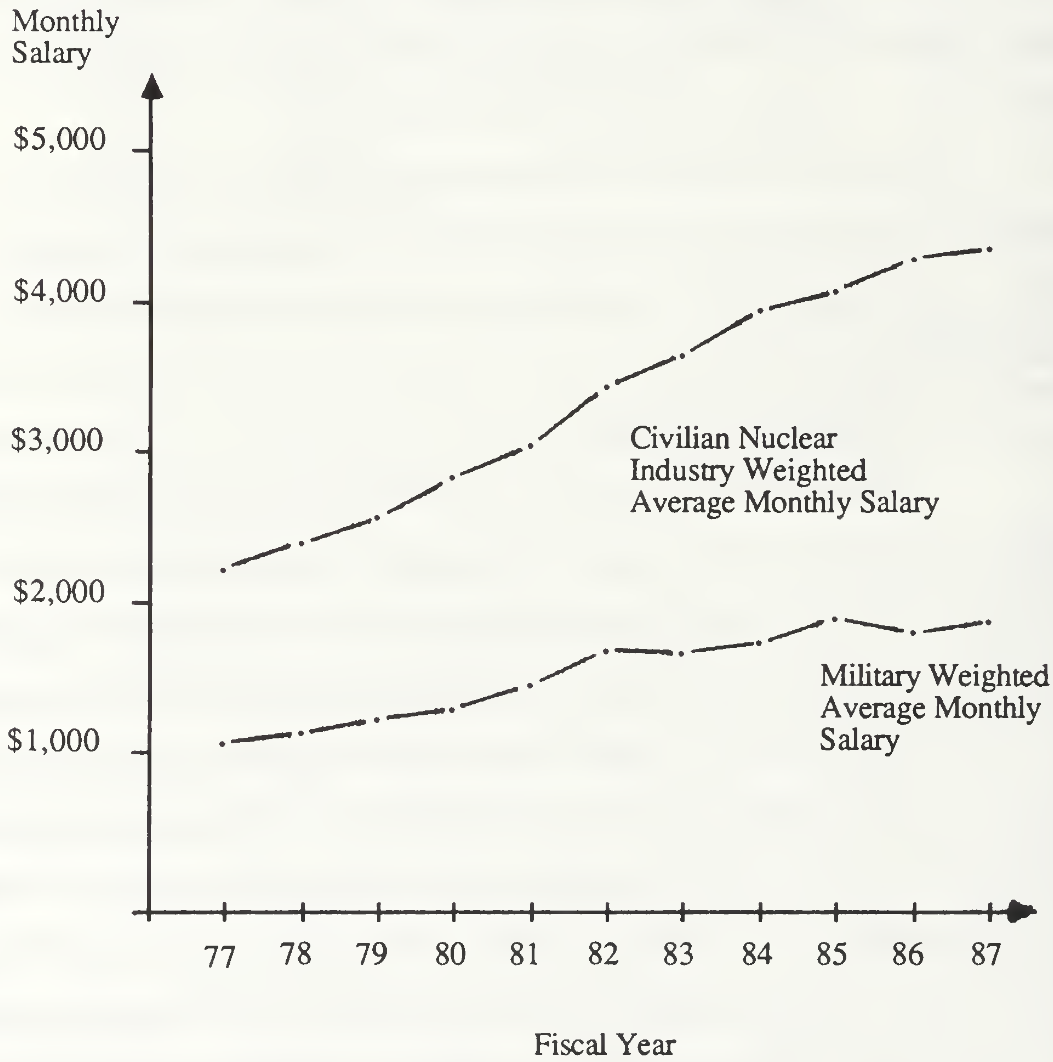

Figure 4

4. Wage Growth

Wage growth in the nuclear industry clearly outpaced military pay increases. Except for fiscal years 1980 and 1981, when large military pay increases reduced the gap, and 1987, when a slackening of the increase in the industry allowed some NECs to catch up, the pay ratio has declined over the relevant period.

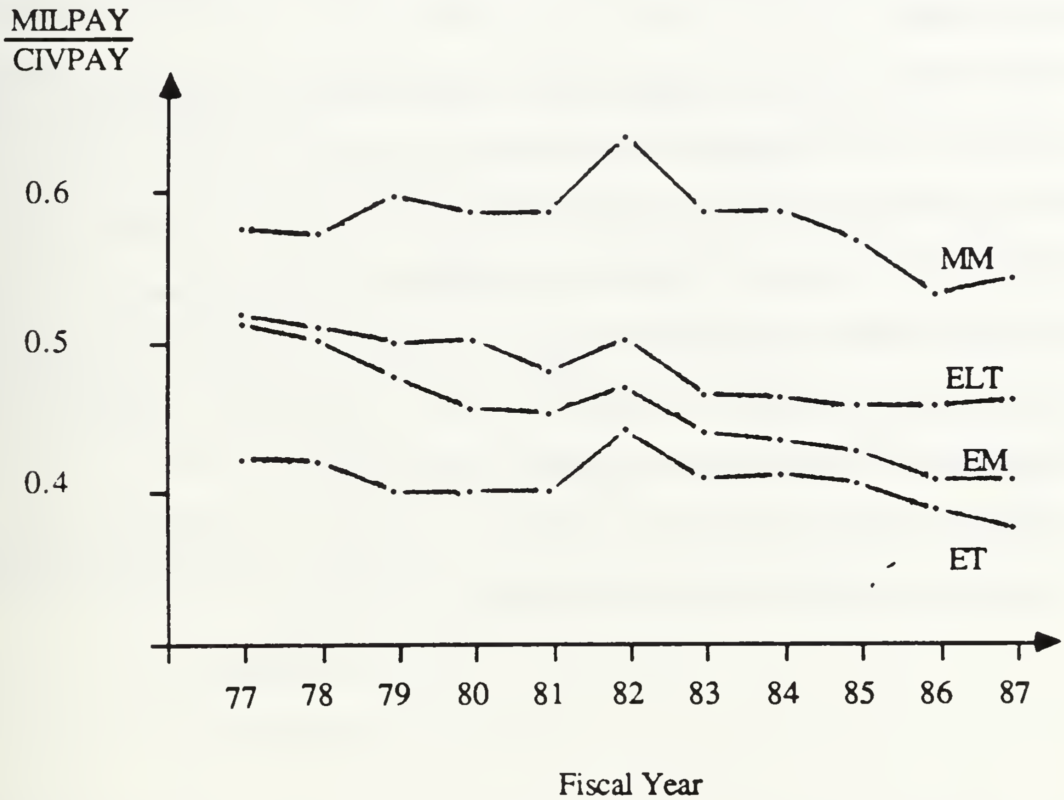

Figure 5

5. Pay Ratios

C. JOB COMPARABILITY

Clearly, the upcoming analysis depends heavily on the presumption that the civilian jobs for which data has been gathered are relevant to the military members under consideration. This linkage is justified in two ways. First, there is evidence that a significant proportion of nuclear trained men do consider civilian nuclear employment seriously. A survey of submarine career counselors found that about 38 percent of those leaving the Navy whose post-service intentions were known either had jobs in the nuclear industry or would be looking there for employment [Ref 36]. Second, a large proportion of employees of civilian nuclear utilities are Navy veterans.

Both civilian and Navy nuclear plants operate under the same basic principles to produce steam for electrical power generation and propulsion. They have similar organizations during operation, with operators manning control stations at key locations in the plant. Long hours are common in both occupations. Civilian employees are able to specialize to a larger extent than is possible on a Navy ship or submarine where manning is limited by space considerations. But all things considered, the similarities far outnumber the differences.

The next chapter will undertake quantitative analysis which will test the degree to which the data from civilian nuclear employers is relevant.

IV. ANALYSIS

A. RESULTS

Two types of quantitative analysis are performed. The first method looks at individual decisions. A logit model is used, with each of the individuals in the candidate data sets being assigned a 1 or 0 value for each of three variables: REENLIST, EXT (for "extend") and SEP (for "separate"). The data set was constructed as described in the previous chapter so that these are mutually exclusive categories. The software available for performing the iterative maximum likelihood technique required for estimating logit parameters does not incorporate a multiple choice feature, so three models were run. One includes only people who reenlist or separate; another includes only those who extend or separate. The resulting equations for the first two models are shown below. Comparison is between reenlistment to separation and extension to separation.

$$\mathit{ln}\ (\text{REENLIST/SEP}) = \alpha_0 + \alpha \cdot \mathbf{X}$$

$$\mathit{ln}\ (\text{EXT/SEP}) = \beta_0 + \beta \cdot \mathbf{X}$$

where α and β are vectors of parameters and **X** is a vector of factors affecting reenlistment and extension probability, such as pay ratio.

This method does not allow comparison of reenlistment to extension since the samples for the two models are different. There are no reenlisters in the population for which extension probability is estimated and no extenders in the population for which reenlistment is estimated. To determine the effect of this problem, a third model was run in which all candidates were included. Here the dependent variables dependent variables are probability of reenlistment compared to either extending or separating, and probability of extension compared to either reenlisting or separating. Perhaps because there were such small probabilities of reenlistment and extension overall, 10.9 percent and 4.9 percent respectively, there was little difference in the results.

The second method of analysis, model B, uses grouped data. Here, reenlistment rates and extension rates are calculated for each of 44 cells. Four NEC categories and 11 years of data allow simple regression of pay ratio against reenlistment and extension rates.

For both models A and B, the pay and unemployment values are those in effect during the year preceding the actual reenlistment, extension, or separation. Although the ACOL model of choice makes sense, it is proposed here that choices are made in advance of the actual contract expiration date, based upon conditions as they are "now."

1. Model A: Individual Level Method

Parameter estimates of the logit model are presented below. As expected there is a lot of unexplained variance in extension rate that is picked up by the dummy variables for the years and by the unemployment rate variable.

Table 13

MODEL A RESULTS (LOGIT)

	REENLISTMENT		EXTENSION	
Variable	β coefficient	(standard error)	β coefficient	(standard error)
PAYRATIO	0.38	(0.38)	0.79	(0.52)
UNEMPLOYMENT	0.37	(0.35)	3.23**	(0.54)
AGE	-0.08**	(0.02)	-0.09**	(0.03)
MARRIED	0.55**	(0.07)	0.45**	(0.10)
FIRST-TERM	-1.18**	(0.08)	-0.82**	(0.11)
AFQT	-0.004*	(0.002)	-0.01**	(0.002)
EM	-0.28**	(0.09)	0.25*	(0.13)
ET	-0.10	(0.08)	0.15	(0.12)
ELT	-0.32**	(0.09)	0.46**	(0.13)
1978	0.52	(0.77)	7.69**	(1.23)
1979	0.84	(0.95)	9.20**	(1.50)
1980	-0.22	(0.40)	2.06**	(0.64)
1981	-0.06	(0.14)	0.27	(0.19)
1982	-0.39	(0.74)	-6.30**	(1.10)
1983	-1.83	(2.33)	-21.26**	(3.57)
1984	-0.40	(0.95)	-8.37**	(1.42)
1985	0.15	(0.18)	-0.73**	(0.23)

* = significant at .05 level
** = significant at .01 level

The coefficient estimates for pay and unemployment are positive, but not significant. The sign of the coefficient on age indicates that older men, *ceteris paribus*, are less likely to reenlist. This result is surprising. It is contrary to beliefs that most analysts hold based on theory and on multiple sources of independent evidence. The finding is less troublesome when one recalls that some of the impact of age is captured in the coefficient on the first-term variable. This latter coefficient has the appropriate sign. That is, it shows that *ceteris paribus* a first termer is less likely to reenlist. Married members are more likely to reenlist, and men with higher AFQT scores are less likely to reenlist. EMs and ELTs have lower reenlistment probabilities than MMs.

The effect of race on reenlistment was not determined because there are too few non-whites in the sample population. Despite the Navy's affirmative action goals, the fact is that a relatively smaller proportion of minorities are able to meet the presently established AFQT score requirements to qualify for entry into nuclear propulsion training.

Consideration of supervisory versus non-supervisory NECs was not included in the model due to collinearity with the dummy variable for length of service.

Extension is modeled only to account for the fact that it is an alternative to reenlistment and separation. There is no attempt here to properly model the extension decision, and as a result the parameter estimates should be viewed with caution. Pay has a positive but insignificant effect in this model too, but unemployment has a much stronger effect than in the reenlistment model. Presumably this is due to the inability of the other explanatory variables to account for the variance of extension rate. Extension decisions can be made for many reasons, and clearly one is to wait for a bad civilian job market to improve. But the extraordinarily high unemployment elasticity of 23.3 predicted by the extension model is unrealistic.

2. Model B: Grouped Data Method

Initial attempts with model B were dissatisfying, but proper treatment of the complex error structure eventually yielded good results. Ordinary least squares regression using reenlistment rate as the dependent variable produced similar outcomes as for model A. The coefficient on PAYRATIO was positive, but not statistically significant. Parameter estimates are presented in Table 14.

Table 14

MODEL B RESULTS, FIRST ATTEMPT
(REENLISTMENT)

Variable	β coefficient	(standard error)	t-statistic
PAYRATIO	0.393	(0.242)	1.63
UNEMPLOYMENT	0.094*	(0.035)	2.72
EM	0.019	(0.032)	0.60
ET	0.051	(0.042)	1.23
ELT	0.005	(0.026)	0.20
1978	0.100*	(0.043)	2.35
1979	0.139*	(0.051)	2.74
1980	-0.045*	(0.017)	-2.67
1981	-0.093**	(0.032)	-2.87
1982	-0.297*	(0.121)	-2.45
1983	-0.244	(0.115)	-1.23
1984	-0.016	(0.030)	-0.53
1985	-0.002	(0.017)	-0.10

* = significant at .05 level
** = significant at .01 level
F = 7.468
$R^2 = 0.68$

The first modification was to simulate a logit specification by the transformation suggested by Hosek and Peterson [Ref. 31]. This involves creation of new dependent variables

ln (r/s) for reenlistment
ln (e/s) for extension

where r = reenlistment rate
e = extension rate
s = separation rate = 1 - (r + e)

This transformation allows use of ordinary least squares regression while preserving the property that all rates sum to unity. It also accounts for the fact that probability models are limited to the {0,1} interval, and so linear models are inappropriate. The results of this model are not substantially different than the first, however. (See Table 15.) Both F-statistic and adjusted R-squared values are about the same, and only small changes are evident in the behavior of the NEC and year dummies.

Table 15

MODEL B RESULTS, SECOND ATTEMPT
(REENLISTMENT)
Log Odds of Dependent Variable

Variable	β coefficient	(standard error)	t-statistic
PAYRATIO	2.11	(2.60)	0.81
UNEMPLOYMENT	1.08**	(0.37)	2.91
EM	-0.06	(0.34)	-0.18
ET	0.19	(0.45)	0.42
ELT	-0.10	(0.28)	-0.37
1978	1.24*	(0.46)	2.71
1979	1.68**	(0.55)	3.07
1980	-0.53**	(0.18)	-2.92
1981	-1.05**	(0.35)	-3.01
1982	-3.30*	(1.31)	-2.53
1983	-2.88*	(1.23)	-2.33
1984	-0.25	(0.32)	-0.77
1985	-0.03	(0.19)	-0.17

* = significant at .05 level
** = significant at .01 level
F = 7.61
R^2 = 0.69

Some subtle problems with this type of time series cross sectional data analysis have been noted. In particular, the ordinary least squares (OLS) technique yields unbiased but inefficient estimators when the error term of the regression equation is correlated among observations. OLS will yield efficient estimators only if the errors among the four NEC categories in a given year are mutually independent on all dimensions except those specified in the model, and if the errors among all annual observations for an NEC category are also mutually independent. For pooled time-series cross-sectional data, this assumption is erroneous and causes an increase in the variance of the parameter estimates, leading to low confidence of statistical significance.

Techniques have been developed to handle this problem. A SAS subroutine called TSCSREG has been written which derives from a 1971 text by Jan Kmenta [Ref. 37]. See Appendix B for details. Using the Parks method of the TSCSREG subroutine, much better results were obtained. The Hosek & Peterson transformations of the dependent variable were retained.

Table 16

FINAL MODEL B RESULTS
(REENLISTMENT)
TSCSREG Procedure

Variable	β coefficient	(standard error)	t-statistic
PAYRATIO	1.01**	(0.103)	9.83
UNEMPLOYMENT	1.06**	(0.068)	15.68
EM	-0.16*	(0.074)	-2.13
ET	0.08	(0.099)	0.78
ELT	-0.09	(0.135)	-0.70
1978	1.22**	(0.089)	13.77
1979	1.71**	(0.104)	16.53
1980	-0.47**	(0.038)	-12.26
1981	-0.99**	(0.064)	-15.39
1982	-3.17**	(0.229)	-13.83
1983	-2.77**	(0.226)	-12.25
1984	-0.18**	(0.063)	-2.92
1985	0.03	(0.039)	0.80

* = significant at .05 level
** = significant at .01 level

Treating the error structure in the proper way results in great increases in significance of the parameter estimates. The pay elasticity of reenlistment is determined to be $\eta = 0.35$.

B. SENSITIVITY ANALYSIS

Some possibly critical assumptions were made in the construction of military and civilian pay variables for these models. After success was achieved with model B, a sensitivity analysis was performed. By changing the assumptions slightly, new estimates were produced and compared to the estimates of table 15 above.

First and most important is the hypothesis that the nuclear industry pay data used will perform better than aggregated and non-specific measures of alternative compensation for nuclear trained enlisted men. The TSCSREG procedure was run with new PAYRATIO calculated using average weekly earnings in manufacturing data published by the Bureau of Labor Statistics. This model produced a substantially lower and barely significant parameter estimate for pay ratio. The estimate was negative for the extension equation. The model as a whole performed less well also; mean square error increased by about 10 percent.

The other critical assumption concerned overtime in the nuclear industry. Removing the factors that increased civilian pay by 1.3 to 1.5 had the expected effect of lowering the parameter estimates for pay ratio. The coefficient on pay in the reenlistment equation fell by 32 percent, but the high statistical confidence was retained. Thus this assumption is important to the magnitude of parameters and elasticities, but not crucial to the general conclusions.

Finally, the three year reenlistment assumption was changed to four years; the model was not sensitive to the change.

C. COMPARISON OF THE MODELS

The most important result of this thesis is the determination of the influence of pay on reenlistment. Table 17 summarizes the findings.

Table 17

SUMMARY OF PAY ELASTICITIES

	MODEL A Logit	MODEL B OLS	MODEL B Logit Simulation	MODEL B (final) TSCSREG
Pay Elasticity of Reenlistment	0.16[a]	1.92[a]	0.95[a]	0.35

a = not statistically significant

The TSCSREG model is clearly superior, primarily because it was the only one to estimate a coefficient of PAYRATIO with sufficient statistical confidence. It provided uniformly more significant estimators for all explanatory variables.

The significance of dummy variables in the reenlistment equation is interesting. The results can be explained partially by inspection of pay ratios and of reenlistment rates during the period. Large military pay increases in fiscal 1981 and 1982 increased PAYRATIO for 1981 and 1982 candidates, while reenlistment rates were lower than would have been predicted by the pay increases alone. Refer to Figures 3 and 5 of the previous chapter. This is presumably due to a lag in the effect of changing pay. Many individuals with 1982 ETS dates probably made up their minds not to reenlist before the fiscal 1981 pay raise went into effect. Once a decision like that is made, it is hard to reconsider. The 1981 pay increase probably had much more impact on those who made reenlistment decisions in later years.

D. LIMITATIONS

Several limitations were encountered during the course of this research. The most significant are described in this section.

First, since the ORC surveys include only shareholder owned utilities, seven public nuclear facilities are not included in the data. It is assumed that competition in the industry will cause the pay rates at those plants to be substantially the same as those found by the surveys.

Second, the treatment of Navy electricians (EMs) by this methodology was imperfect. The relevant positions were taken to be control operator (E331) and electrician (E414). The control operator job is most closely analogous to the Navy job done by Electronics Technicians (ETs), but it is assumed here that at least some electricians can qualify. Data is not available to assess the extent to which this job is filled by non ETs. The assumption made by the data analysis here is that the pay of EMs can be accurately represented by a weighted average of the two positions as was done for the other three NECs. This may not be accurate.

Third, due to the method of counting reenlistments and extensions, there are some unobserved decisions. Candidates who appeared in the data file of the following year with the same ETS date were deleted from the analysis and therefore also not observed. These missing observations are assumed to be a random sample of the entire population of candidates.

Fourth, the assumptions made in order to calculate salaries were imperfect. Accumulating all the candidates into three military pay categories was simplifying but inaccurate. Sufficient information is available to specify present military pay precisely. Also, only current pay information was used. The ACOL framework could have been employed to calculate present value pay comparisons for these men. The method used here assumes a zero discount rate, which is obviously not the case.

Finally, the desire to use the same model for reenlistment and extension caused improper specification of the extension equation, both due to the inclusion of the bonus in calculation of military pay and due to exclusion of variables which are uniquely relevant to extension such as gaps in SRB coverage and time of year. Since the purpose of this thesis is to analyze reenlistment behavior, these imperfections are not important.

The analysis herein could be refined by systematically accounting for these limitations in a different way than is done in this paper.

V. CONCLUSIONS

The analysis conducted for this thesis confirms the significance of pay in reenlistment decisions. It also supports the hypothesis that unemployment has an important impact on extension decisions. In addition, the age, family status, AFQT, and time in service variables have significant impacts on reenlistments in both cases.

The usefulness of sophisticated econometric techniques was also demonstrated. Statistically significant results for pay effects were obtained only after taking into account the cross-sectional and time-dependent correlations, and only after allowing for heteroskedasticity that exist in data of the type used here.

A. COMPARISONS WITH PREVIOUS WORK

This study is distinct from other research focusing on "first-term" retention in several ways. One difference is the time in service and age of those in the sample. For many of these men, the first real choice to get out of the Navy comes at the 8 year point. Most studies consider the first term of enlistment to be four years. At least one study omitted 6 year initial enlistments entirely.

1. Pay

The pay elasticity of 0.35 uncovered by this study is significantly different from those of most other similar research. Previous work has found elasticities consistently greater than unity, with most around 2 to 3.

There are two possible explanations for this result. First, there is evidence that more arduous occupations are less influenced by pay. People are more influenced by other things when those other things are either very good or very bad. Warner and Goldberg, for example, found less elastic supply curves for occupations where there was significant sea duty [Ref. 11]. Men on nuclear ships spend a great deal of time at sea; in general, the sea duty variable is a good measure of how demanding a Navy job is.

Second, the *level* of pay ratios reported in this study differs significantly from that in others. Most research has found relatively small differences in military and civilian pay. But the men in this study can realistically expect to make over twice as much money in the civilian nuclear industry as they can in the Navy, even when reenlistment bonuses are included in Navy pay. Marginal changes in pay ratio can be expected to have a much greater effect when the ratio is close to unity than when it changes from, say, 0.48 to 0.50. In the former case, a military pay raise or bonus multiple change might make the Navy more attractive financially than the best civilian alternative. In the case of nuclear trained enlisted men, military pay changes have almost all been of little consequence due to the magnitude of the difference.

2. Unemployment

As expected, unemployment rate has a positive influence on reenlistment rate. The magnitude of the effect on extension behavior, however, is unusual. The elasticities determined here ranged from 12 to 23. The unemployment variable ranges from 5.1 percent to 9.9 percent with a mean of 7.2 percent. Extension rates range from 1.6 percent to 7.2 percent with a mean of 4.9 percent. Hosek & Peterson's elasticity was 3.27[1] [Ref. 31]; the comparable method on the pooled data

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[1] Calculated from a first derivative of .0322 for the second term, defined as 6-9 years of service.

set used here produces a value of 12.34. This might be due to the relatively small variations in the extension rates in these data. All the dummy variables for year were also significant, implying an inadequacy of the other explanatory variables to explain variance in extension rate.

B. FORECASTS AND RECOMMENDATIONS

Some projection can be done on the basis of the results of this thesis. Earlier discussion presented the reduction of hiring and training costs as one of the values of good retention. Due to their high "quality" (as defined by the Navy), nuclear trained men are particularly hard to attract to the service. Many aspire to college education and professional careers. On one hand, the academic nature of the nuclear propulsion training is appealing to these men. On the other hand, many of them tend to be dissatisfied with life in the enlisted Navy.

A more important aspect from the Navy's financial point of view is the cost of that training. Nuclear training takes over a year, during which time members receive full pay, allowances, and benefits. For a typical E-4, this amounts to about $10,000 in basic pay alone.[2] Add to this the cost of operating and maintaining the facilities and the costs of military and civilian staff at the training sites, and it is clear that the investment in training is significant. The second phase of training in particular is very expensive since it takes place at an operating nuclear prototype plant which exists solely for training and research.

The prospect of spending up to $30,000 for a reenlistment bonus which will avoid the necessity of recruiting and training a replacement is obviously appealing.

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[2] Based upon the FY1988 pay tables.

If present trends in pay continue, holding all other variables constant, the average military to civilian pay ratio for this group will be 0.396 in fiscal year 1990. This represents a decrease of 11.6 percent from the 1987 value of 0.448, and is estimated to lead to a decrease in the average reenlistment rate of 4.1 percent. This amounts to a change from 11.1 to 10.65 percent.

The pay increase necessary to recover the 1987 reenlistment rate would be about $250 per month. This 13.2 percent increase in compensation could be achieved by a basic pay raise or by increasing the SRB multiple by about 1.5 points, giving the average 3 year reenlistee an additional $9000. Such an increase would require raising the statutory cap above $30,000. Note that the 13.2 percent pay raise required is *in addition to* the annual raises already taken into account by extrapolating the trend of the last few years.

The inelasticity of labor supply in this sector is detrimental to Navy efforts to meet retention goals using financial resources. SRBs are clearly the most efficient tool now available to maintain the status quo.

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APPENDIX A

WRITING DMDC DATA TO DISK FILE

```
//DMDC86D   JOB (0529,9999),'DC SAS',CLASS=C
//*MAIN SYSTEM=SY2
//   EXEC SAS
//WORK DD SPACE=(CYL,(20,20))
//TDATA DD DISP=SHR,DSN=MSS.S0529.DCSAS
//DD1 DD DISP=(OLD,KEEP),DSN=MSS.S0529.MATCH3
//SYSIN DD *


DATA TRY2;
  SET TDATA.THESIS;
IF DTRANKY=0 THEN DELETE;
IF DTRANKM=0 THEN DELETE;
IF DATENLY=0 THEN DELETE;
IF DATENLM=0 THEN DELETE;
IF ETSY=0 THEN DELETE;
IF ETSM=0 THEN DELETE;
D=28+0;
ETS=MDY (ETSM,D,ETSY);
DATENL=MDY(DATENLM,D,DATENLY);
DATRANK=MDY(DTRANKM,D,DTRANKY);
Y=YEAR+74;
M=09;
NOW=MDY(M,D,Y);
TIMELEFT=ETS-NOW;

DATA CAND75;
 SET TRY2;
  IF Y=75;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1976;
 SET TRY2;
  IF Y=76;

DATA NEW76;
 SET Y1976;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND75;
 BY ID;
PROC SORT  DATA=NEW76;
 BY ID;
DATA DD1.MATCH75A;
 MERGE CAND75 NEW76;
  BY ID;


DATA CAND76;
 SET TRY2;
  IF Y=76;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;
```

```
DATA Y1977;
 SET TRY2;
  IF Y=77;

DATA NEW77;
 SET Y1977;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND76;
 BY ID;
PROC SORT  DATA=NEW77;
 BY ID;
DATA DD1.MATCH76A;
 MERGE CAND76 NEW77;
  BY ID;


DATA CAND77;
 SET TRY2;
  IF Y=77;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1978;
 SET TRY2;
  IF Y=78;

DATA NEW78;
 SET Y1978;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND77;
 BY ID;
PROC SORT  DATA=NEW78;
 BY ID;
DATA DD1.MATCH77A;
 MERGE CAND77 NEW78;
  BY ID;


DATA CAND78;
 SET TRY2;
  IF Y=78;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1979;
 SET TRY2;
  IF Y=79;

DATA NEW79;
 SET Y1979;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND78;
 BY ID;
```

```
PROC SORT  DATA=NEW79;
 BY ID;
DATA DD1.MATCH78A;
 MERGE CAND78 NEW79;
  BY ID;

DATA CAND79;
 SET TRY2;
  IF Y=79;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1980;
 SET TRY2;
  IF Y=80;

DATA NEW80;
 SET Y1980;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND79;
 BY ID;
PROC SORT  DATA=NEW80;
 BY ID;
DATA DD1.MATCH79A;
 MERGE CAND79 NEW80;
  BY ID;


DATA CAND80;
 SET TRY2;
  IF Y=80;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1981;
 SET TRY2;
  IF Y=81;

DATA NEW81;
 SET Y1981;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND80;
 BY ID;
PROC SORT  DATA=NEW81;
 BY ID;
DATA DD1.MATCH80A;
 MERGE CAND80 NEW81;
  BY ID;


DATA CAND81;
 SET TRY2;
  IF Y=81;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1982;
 SET TRY2;
  IF Y=82;
```

```
DATA NEW82;
 SET Y1982;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND81;
 BY ID;
PROC SORT  DATA=NEW82;
 BY ID;
DATA DD1.MATCH81A;
 MERGE CAND81 NEW82;
  BY ID;


DATA CAND82;
 SET TRY2;
  IF Y=82;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1983;
 SET TRY2;
  IF Y=83;

DATA NEW83;
 SET Y1983;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND82;
 BY ID;
PROC SORT  DATA=NEW83;
 BY ID;
DATA DD1.MATCH82A;
 MERGE CAND82 NEW83;
  BY ID;


DATA CAND83;
 SET TRY2;
  IF Y=83;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1984;
 SET TRY2;
  IF Y=84;

DATA NEW84;
 SET Y1984;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND83;
 BY ID;
PROC SORT  DATA=NEW84;
 BY ID;
DATA DD1.MATCH83A;
 MERGE CAND83 NEW84;
  BY ID;
```

```
DATA CAND84;
 SET TRY2;
  IF Y=84;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1985;
 SET TRY2;
  IF Y=85;

DATA NEW85;
 SET Y1985;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND84;
 BY ID;
PROC SORT  DATA=NEW85;
 BY ID;
DATA DD1.MATCH84A;
 MERGE CAND84 NEW85;
  BY ID;


DATA CAND85;
 SET TRY2;
  IF Y=85;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1986;
 SET TRY2;
  IF Y=86;

DATA NEW86;
 SET Y1986;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND85;
 BY ID;
PROC SORT  DATA=NEW86;
 BY ID;
DATA DD1.MATCH85A;
 MERGE CAND85 NEW86;
  BY ID;
```

```
DATA CAND86;
 SET TRY2;
  IF Y=86;
  IF TIMELEFT LE 395 THEN CAND=1;
    ELSE CAND=0;
IF CAND=1;

DATA Y1987;
 SET TRY2;
  IF Y=87;

DATA NEW87;
 SET Y1987;
  RENAME Y=NY DATENL=NDATENL DATRANK=NDATRANK ETS=NETS
         NEC=NNEC DEP=NDEP MARSTAT=NMARSTAT PAYGRD=NPAYGRD
         EDUC=NEDUC TAFMS=NTAFMS TIMELEFT=NTMLEFT;

PROC SORT  DATA=CAND86;
 BY ID;
PROC SORT  DATA=NEW87;
 BY ID;
DATA DD1.MATCH86A;
 MERGE CAND86 NEW87;
  BY ID;




//
/*
```

WRITING ECONOMIC DATA TO DISK FILE

```
//P_DATA6    JOB (0529,9999),'DATA SAS',CLASS=A
//*MAIN SYSTEM=SY2
//   EXEC SAS
//DD1 DD DISP=(OLD,KEEP),DSN=MSS.S0529.MYDATA
//SYSIN DD *

DATA DATA1;
 INPUT  YEAR 1-4  UNEMPAG 6-9 .1  UNEMPMEN 11-14 .1  MFGAWE 16-21 .2
        U_M2024A 23-26 .1  U_M2529A 28-31 .1  U_M3034A 33-36 .1
        UWM2529A 38-41 .1  UBM2529A 43-46 .1
    #2  CPAYE331 1-4  PREME331 6-8  CPAYE334 10-13  CPAYE343 15-18
        CPAYE346 20-23  CPAYE349 25-28  CPAYE352 30-33  CPAYE390 35-38
        CPAYE408 40-43  CPAYE414 45-48
    #3  NUME331 1-4  NUME334 6-9  NUME343 11-14
        NUME346 16-19  NUME349 21-24  NUME352 26-29  NUME390 31-34
        NUME408 36-39  NUME414 41-44
    #4  EMSRBA 1-3 .1  EMSRBB 5-7 .1  ETSRBA 9-11 .1  ETSRBB 13-15 .1
        ELSRBA 17-19 .1  ELSRBB 21-23 .1  MMSRBA 25-27 .1
        MMSRBB 29-31 .1
    #5  PSAWE 1-6 .2  CPI 8-12 .1  BPAYE5_6 14-20 .2  BPAYE6_6 22-28 .
        BPAYE6_8 30-36 .2  BAQ5 38-43 .2  BAQ6 45-50 .2
    #6  U_M2024B 3-6 .1 U_M2529B 8-11 .1 U_M3034B 13-16 .1
        UWM2529B 18-21 .1  UBM2529B 23-26 .1
    #7  NPO331 3-6  VAC331 8-10  NPO334 12-15  VAC334 17-19
        NPO349 21-24  VAC349 26-28  NPO343 30-33  VAC343 35-37
        NPO390 39-42  VAC390 44-46  NPO408 48-51  VAC408 53-55
        NPO414 57-60  VAC414 62-64
    #8  NPOTRO 3-5  VACTRO 7-8  NPOTNL 10-12  VACTNL 14-15
    #9  SEPAY5_9 3-5  SEPAY5_8 7-9  SEPAY5_7 11-13  SEPAY5_6 15-17
        SEPAY5_5 19-21  SEPAY5_4 23-25  SEPAY5_3 27-29
   #10  SEPAY6_9 3-5  SEPAY6_8 7-9  SEPAY6_7 11-13  SEPAY6_6 15-17
        SEPAY6_5 19-21  SEPAY6_4 23-25  SEPAY6_3 27-29
;

  LABEL PSAWE = 'PRIVATE SECTOR AVG WEEKLY EARNINGS'
        CPI = 'CONSUMER PRICE INDEX'
        BPAYE5_6 = 'BASIC PAY - E5 WITH 6 YEARS OF SERVICE'
        BPAYE6_6 = 'BASIC PAY - E6 WITH 6 YEARS OF SERVICE'
        BPAYE6_8 = 'BASIC PAY - E6 WITH 8 YEARS OF SERVICE'
        BAQ5 = 'BASIC ALLOW. FOR QUARTERS, E5'
        BAQ6 = 'BASIC ALLOW. FOR QUARTERS, E6'
        PREME331 = 'PREMIUM FOR OCCUPATION 331'
        CPAYE331 = 'CIV NUC AVERAGE MONTHLY PAY, OCCUP 331'
        CPAYE334 = 'CIV NUC AVERAGE MONTHLY PAY, OCCUP 334'
        CPAYE343 = 'CIV NUC AVERAGE MONTHLY PAY, OCCUP 343'
        CPAYE346 = 'CIV NUC AVERAGE MONTHLY PAY, OCCUP 346'
        CPAYE349 = 'CIV NUC AVERAGE MONTHLY PAY, OCCUP 349'
        CPAYE352 = 'CIV NUC AVERAGE MONTHLY PAY, OCCUP 352'
        CPAYE390 = 'CIV NUC AVERAGE MONTHLY PAY, OCCUP 390'
        CPAYE408 = 'CIV NUC AVERAGE MONTHLY PAY, OCCUP 408'
        CPAYE414 = 'CIV NUC AVERAGE MONTHLY PAY, OCCUP 414'
        NUME331 = 'NUMBER OF INCUMBENTS, OCCUP 331'
        NUME334 = 'NUMBER OF INCUMBENTS, OCCUP 334'
        NUME343 = 'NUMBER OF INCUMBENTS, OCCUP 343'
        NUME346 = 'NUMBER OF INCUMBENTS, OCCUP 346'
        NUME349 = 'NUMBER OF INCUMBENTS, OCCUP 349'
        NUME352 = 'NUMBER OF INCUMBENTS, OCCUP 352'
        NUME390 = 'NUMBER OF INCUMBENTS, OCCUP 390'
        NUME408 = 'NUMBER OF INCUMBENTS, OCCUP 408'
        NUME414 = 'NUMBER OF INCUMBENTS, OCCUP 414'
        EMSRBA= 'ZONE A SRB MULTIPLE FOR ELECTRICIANS'
        EMSRBB = 'ZONE B SRB MULTIPLE FOR ELECTRICIANS'
        ETSRBA= 'ZONE A SRB MULT FOR ELECTRONICS TECHS'
        ETSRBB = 'ZONE B SRB MULT FOR ELECTRONICS TECHS'
        ELSRBA= 'ZONE A SRB MULT FOR ELTS'
```

```
        ELSRBB = 'ZONE B SRB MULT FOR ELTS'
        MMSRBA= 'ZONE A SRB MULT FOR MACHINISTS MATES'
        MMSRBB = 'ZONE B SRB MULT FOR MACHINISTS MATES'
        UNEMPAG = 'AGGREGATE NATIONAL UNEMPLOYMENT RATE'
        UNEMPMEN = 'NATIONAL UNEMPLOYMENT RATE AMONG MEN'
        MFGAWE = 'AVG WEEKLY EARNINGS IN MANUFACTURING'
        U_M2024A = 'UNEMPLOYMENT RATE AMONG MEN, 20-24 YRS'
        U_M2024B = 'UNEMP AMONG MEN, 20-24 YRS, LAG 6 MO.'
        U_M2529A = 'UNEMPLOYMENT RATE AMONG MEN, 25-29 YRS'
        U_M2529B = 'UNEMP AMONG MEN, 25-29 YRS, LAG 6 MO.'
        U_M3034A = 'UNEMPLOYMENT RATE AMONG MEN, 30-34 YRS'
        U_M3034B = 'UNEMP AMONG MEN, 30-34 YRS, LAG 6 MO.'
        UWM2529A = 'UMEMP RATE AMONG WHITE MEN, 25-29'
        UWM2529B = 'UMEMP FOR WHITE MEN, 25-29, LAG 6 MO.'
        UBM2529A = 'UMEMP RATE AMONG BLACK MEN, 25-29'
        UBM2529B = 'UMEMP FOR BLACK MEN, 25-29, LAG 6 MO.'
        NPO331 = 'NUMBER OF 331 POSITIONS REPORTED'
        VAC331 = 'NUMBER OF 331 VACANCIES REPORTED'
        NPO334 = 'NUMBER OF 334 POSITIONS REPORTED'
        VAC334 = 'NUMBER OF 334 VACANCIES REPORTED'
        NPO349 = 'NUMBER OF 349 POSITIONS REPORTED'
        VAC349 = 'NUMBER OF 349 VACANCIES REPORTED'
        NPO343 = 'NUMBER OF 343 POSITIONS REPORTED'
        VAC343 = 'NUMBER OF 343 VACANCIES REPORTED'
        NPO390 = 'NUMBER OF 390 POSITIONS REPORTED'
        VAC390 = 'NUMBER OF 390 VACANCIES REPORTED'
        NPO408 = 'NUMBER OF 408 POSITIONS REPORTED'
        VAC408 = 'NUMBER OF 408 VACANCIES REPORTED'
        NPO414 = 'NUMBER OF 414 POSITIONS REPORTED'
        VAC414 = 'NUMBER OF 414 VACANCIES REPORTED'
        NPOTRO = 'IN TRAINING FOR REACTOR OPERATOR'
        NPOTNL = 'IN TRAINING FOR NON-LICENSED POSITION'
        VACTRO = 'NUMBER OF VACANCIES TRO'
        VACTNL = 'NUMBER OF VACANCIES TNL'
        SEPAY5_9 = 'SEA PAY -- E-5 WITH OVER 9 YEARS AT SEA'
        SEPAY5_8 = 'SEA PAY -- E-5 WITH OVER 8 YEARS AT SEA'
        SEPAY5_7 = 'SEA PAY -- E-5 WITH OVER 7 YEARS AT SEA'
        SEPAY5_6 = 'SEA PAY -- E-5 WITH OVER 6 YEARS AT SEA'
        SEPAY5_5 = 'SEA PAY -- E-5 WITH OVER 5 YEARS AT SEA'
        SEPAY5_4 = 'SEA PAY -- E-5 WITH OVER 4 YEARS AT SEA'
        SEPAY5_3 = 'SEA PAY -- E-5 WITH OVER 3 YEARS AT SEA'
        SEPAY6_9 = 'SEA PAY -- E-6 WITH OVER 9 YEARS AT SEA'
        SEPAY6_8 = 'SEA PAY -- E-6 WITH OVER 8 YEARS AT SEA'
        SEPAY6_7 = 'SEA PAY -- E-6 WITH OVER 7 YEARS AT SEA'
        SEPAY6_6 = 'SEA PAY -- E-6 WITH OVER 6 YEARS AT SEA'
        SEPAY6_5 = 'SEA PAY -- E-6 WITH OVER 5 YEARS AT SEA'
        SEPAY6_4 = 'SEA PAY -- E-6 WITH OVER 4 YEARS AT SEA'
        SEPAY6_3 = 'SEA PAY -- E-6 WITH OVER 3 YEARS AT SEA'
;

CARDS;
1975  8.5  7.9 190.79 12.8  7.6  4.8  5.7 11.5
.    .    .     .     .     .    .    .    .    .
.    .    .     .     .     .    .    .    .    .
6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0
163.53 161.2  573.90  632.70  656.10102.60 106.20
  16.2  9.7  6.7  7.7 13.5
  .    .    .    .    .    .    .    .    .    .    .    .    .    .
  .   .   .   .
   16   16   16   16   16   16   16
   20   20   20   20   20   20   20
1976  7.7  7.1 209.32 10.4  7.0  4.4  5.3 10.4
.    .    .     .     .     .    .    .    .    .
.    .    .     .     .     .    .    .    .    .
6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0
175.45 170.5  594.60  655.50  679.80 112.50 117.00
  14.5  8.6  6.5  6.9 13.7
  .    .    .    .    .    .    .    .    .    .    .    .    .    .
```

```
  .  .  .  .
   16  16  16  16  16  16  16
   20  20  20  20  20  20  20
1977  7.1  6.3 228.90 10.0  6.0  4.6  4.6 10.8
1513 .   1265 1709 1767 1403 1445 1760 1498 1450
 467  664   50   59  255  276   94 1437 1871
6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0
189.00 181.5  631.50  696.00  721.80 124.20 129.30
  14.6  9.0  5.7  7.0 11.4
  .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
  .  .  .  .
   16  16  16  16  16  16  16
   20  20  20  20  20  20  20
1978  6.1  5.3 249.27  7.7  5.0  2.9  3.5  8.8
1657 .   1382 1872 1824 1512 1545 1716 1636 1548
 549  818   49   94  273  351  104 1159 1504
6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0
203.70 195.3  666.30  734.40  761.50 131.20 136.50
  12.5  6.5  4.6  4.9 11.2
  .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
  .  .  .  .
   35  35  35  35  35  25  25
   35  35  35  35  35  25  25
1979  5.8  5.1 269.34  7.8  4.6  3.8  3.7  8.4
1788 .   1512 2063 1977 1693 1625 2042 1654 1644
 594  932   56  108  350  324  114  361  592
6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0
219.91 217.7  713.10  786.00  814.80 140.40 146.10
  10.2  6.4  3.9  4.4 11.4
  .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
  .  .  .  .
   35  35  35  35  35  25  25
   35  35  35  35  35  25  25
1980  7.1  6.9 288.62 12.4  8.9  5.3  6.4 12.6
1941 .   1641 2265 2397 1865 1799 2307 1813 1824
 775 1010   67   74  363  340  110  349  467
6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0
235.10 247.0  796.50  878.10  910.20 156.90 163.20
   9.5  7.3  6.4  6.1 11.2
  .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
  .  .  .  .
  220 220 220 205 190 185 175
  255 245 235 225 215 185 175
1981  7.6  7.4 318.00 11.6  7.1  5.5  5.5 12.6
2217 186 1798 2592 2403 2077 1961 2065 1980 2005
 734 1242   71  191  386  366  684  403  458
6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0
255.20 272.3  927.90 1023.00 1060.50 179.40 186.60
  15.0  9.0  6.6  7.1 13.7
  .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
  .  .  .  .
  220 220 220 205 190 185 175
  255 245 235 225 215 185 175
1982  9.7  9.9 330.26 15.1 11.4  7.7  8.2 19.4
2492 254 1985 2766 2647 2299 2205 2269 2129 2243
 794 1422   69  219  450  418  709  459  523
5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0
267.26 288.6  965.10 1063.80 1102.80 186.60 194.10
  17.7 11.8  8.3  9.2 17.1
  .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
  .  .  .  .
  220 220 220 205 190 185 175
  255 245 235 225 215 185 175
1983  9.6  9.9 354.08 14.2 10.0  8.1  8.7 21.0
2626 246 2130 2986 2887 2430 2375 2417 2300 2383
 959 1698   83  290  524  619  882  500  684
5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0
280.70 297.4 1003.80 1106.40 1146.90 194.10 201.90
```

```
  20.5 15.3 10.5 13.8 27.6
   .    .    .    .    .    .    .    .    .    .    .    .    .    .
   .    .  .  .
  220 220 220 205 190 185 175
  255 245 235 225 215 185 175
1984  7.5  7.4 374.03 11.1  6.7  5.4  5.6 15.1
2751 291 2230 2947 3063 2588 2467 2536 2340 2509
1017 1741  118  293  592  686  969  518  683
5.0 4.8 5.0 4.8 5.0 4.8 5.0 4.8
292.86 309.4 1044.00 1150.80 1192.80 204.90 221.40
  14.3 10.6  8.1  9.8 17.3
  1318  99 3305 283 1284 142 2301 221 2883 232 4123 458 1883 176
  779 14 755 98
  220 220 220 205 190 185 175
  255 245 235 225 215 210 190
1985  7.2  7.0 386.37  9.9  6.8  5.4  5.8 14.2
2902 302 2386 3217 3256 2728 2602 2665 2548 2681
1098 1690  114  314  661  796 1077  606  771
4.0 4.5 4.0 4.5 6.0 4.5 4.0 4.5
299.09 322.2 1075.30 1185.30 1228.60 211.00 228.00
  13.9  8.6  7.2  7.5 17.8
  1654 193 3370 213 1335 105 2718 181 3298 210 4055 379 1891 104
  553  3 412 40
  220 220 220 205 190 185 175
  255 245 235 225 215 210 190
1986  7.0  6.9 396.01  9.3  6.5  5.4  5.7 13.6
3011 381 2537 3406 3407 2859 2756 2790 2648 2786
1255 1990  139  371  729  952 1249  690  891
3.3 4.6 3.3 4.6 5.8 5.6 3.8 5.6
304.85 328.4 1107.60 1221.00 1265.40 217.20 234.90
  12.6  8.3  7.3  7.3 15.8
  1483  46 3667 190 1350  66 2835 166 3247 157 4451 177 2104 104
  586  2 417 20
  220 220 220 205 190 185 175
  255 245 235 225 215 210 190
1987  6.3  6.3 406.81  8.4  4.6  4.4  4.7 10.9
3149 375 2603 3634 3602 2954 2827 2866 2678 2763
1238 2279  156  330  838 1082 1381 1012 1218
3.2 4.7 3.2 4.7 5.7 5.4 3.7 5.4
314.38 340.8 1129.80 1245.30 1290.60 221.40 239.70
  11.7  7.3  6.1  7.3 14.5
  1620  43 3693 182 1473  62 3087 180 3225 111 3777 141 2159  77
  461  7 407 31
  220 220 220 205 190 185 175
  255 245 235 225 215 210 190
;

DATA DD1.MYDATA;
  SET DATA1;

/*
//
```

COMBINING ECONOMIC WITH DMDC DATA

```
//COMBO18  JOB (0529,9999),'DC SAS',CLASS=C
//*MAIN SYSTEM=SY2
//   EXEC SAS
//WORK DD SPACE=(CYL,(20,20))
//MYDATA DD DISP=SHR,DSN=MSS.S0529.MYDATA
//DD1 DD DISP=(OLD,KEEP),DSN=MSS.S0529.COMBO2
//SYSIN DD *

DATA D75;
  SET TDATA.MATCH75A;
  ENTAGE=ENTAGE+16;
  AGE=ENTAGE+(TAFMS/12);
DATA D76;
  SET TDATA.MATCH76A;
  ENTAGE=ENTAGE+16;
  AGE=ENTAGE+(TAFMS/12);
DATA D77;
  SET TDATA.MATCH77A;
  ENTAGE=ENTAGE+16;
  AGE=ENTAGE+(TAFMS/12);
DATA D78;
  SET TDATA.MATCH78A;
  IF ENTAGE LT 10 THEN ENTAGE=ENTAGE+16;
    ELSE ENTAGE=ENTAGE;
  AGE=ENTAGE+(TAFMS/12);
DATA D79;
  SET TDATA.MATCH79A;
  AGE=ENTAGE+(TAFMS/12);
DATA D80;
  SET TDATA.MATCH80A;
  AGE=ENTAGE+(TAFMS/12);
DATA D81;
  SET TDATA.MATCH81A;
  AGE=ENTAGE+(TAFMS/12);
DATA D82;
  SET TDATA.MATCH82A;
  AGE=ENTAGE+(TAFMS/12);
DATA D83;
  SET TDATA.MATCH83A;
  AGE=ENTAGE+(TAFMS/12);
DATA D84;
  SET TDATA.MATCH84A;
  AGE=ENTAGE+(TAFMS/12);
DATA D85;
  SET TDATA.MATCH85A;
  AGE=ENTAGE+(TAFMS/12);
DATA D86;
  SET TDATA.MATCH86A;
  AGE=ENTAGE+(TAFMS/12);

DATA D75_86;
  SET D75 D76 D77 D78 D79 D80 D81 D82 D83 D84 D85 D86;

DATA NUMBERS;
  SET MYDATA.MYDATA;
Y=YEAR-1900;

PROC SORT  DATA=D75_86;
  BY Y;
PROC SORT  DATA=NUMBERS;
  BY Y;
DATA ALL1;
  MERGE D75_86 NUMBERS;
  BY Y;
```

```
DATA DD1.ALL5;
  SET ALL1;

IF TIMELEFT LT -125 THEN DELETE;
IF YEAR GT 1900 THEN YEAR=YEAR-1974;

IF TAFMS GE 48 AND TAFMS LT 60 THEN YOS=4;
IF TAFMS GE 60 AND TAFMS LT 72 THEN YOS=5;
IF TAFMS GE 72 AND TAFMS LT 84 THEN YOS=6;
IF TAFMS GE 84 AND TAFMS LT 96 THEN YOS=7;
IF TAFMS GE 96 AND TAFMS LT 108 THEN YOS=8;
IF TAFMS GE 108 THEN YOS=9;

DIFF=NETS-ETS;

IF DIFF=0 THEN SAME=1;
  ELSE SAME=0;
IF DIFF GE 1090 THEN REENLIST=1;
  ELSE REENLIST=0;
IF DIFF LT 0 THEN OUT=1;
  ELSE OUT=0;
IF DIFF GT 0 AND DIFF LT 1090 THEN EXT=1;
  ELSE EXT=0;
IF NETS=. THEN SEP=1;
  ELSE SEP=0;

IF SEP=1 THEN CODE=0;
IF REENLIST=1 THEN CODE=1;
IF EXT=1 THEN CODE=2;
  LABEL CODE='EXT=2, REENLIST=1,LEAVE=0';

//
/*
```

CREATING NEW VARIABLES WHICH PUT 19XX SURVEY DATA
IN 19XX FILE

```
//WRITE3    JOB (0529,9999),'COOK 649-3913',CLASS=C
//*MAIN SYSTEM=SY2
//   EXEC SAS
//WORK DD SPACE=(CYL,(10,10))
//ALL1 DD DISP=SHR,DSN=MSS.S0529.COMB02
//ALL2 DD DISP=SHR,DSN=MSS.S0529.COMB03
//DD1 DD DISP=(OLD,KEEP),DSN=MSS.S0529.COMB03
//SYSIN DD *

DATA DATA1;
  INPUT YEAR 1-4
   #2   NCPE331 1-4  PREME331 6-8  NCPE334 10-13  NCPE343 15-18
        NCPE346 20-23  NCPE349 25-28  NCPE352 30-33  NCPE390 35-38
        NCPE408 40-43  NCPE414 45-48
   #3   NNUM331 1-4  NNUM334 6-9  NNUM343 11-14
        NNUM346 16-19  NNUM349 21-24  NNUM352 26-29  NNUM390 31-34
        NNUM408 36-39  NNUM414 41-44
   #4   NOTHING 1
;

Y=YEAR-1900;

CARDS;
1976
1513 .   1265 1709 1767 1403 1445 1760 1498 1450
 467  664   50   59  255  276   94 1437 1871

1977
1657 .   1382 1872 1824 1512 1545 1716 1636 1548
 549  818   49   94  273  351  104 1159 1504
  77  6.1  5.3 249.27  7.7  5.0  2.9  3.5  8.8

1978
1788 .   1512 2063 1977 1693 1625 2042 1654 1644
 594  932   56  108  350  324  114  361  592
  78  5.8  5.1 269.34  7.8  4.6  3.8  3.7  8.4

1979
1941 .   1641 2265 2397 1865 1799 2307 1813 1824
 775 1010   67   74  363  340  110  349  467

1979
1941 .   1641 2265 2397 1865 1799 2307 1813 1824
 775 1010   67   74  363  340  110  349  467

1980
2217 186 1798 2592 2403 2077 1961 2065 1980 2005
 734 1242   71  191  386  366  684  403  458

1981
2492 254 1985 2766 2647 2299 2205 2269 2129 2243
 794 1422   69  219  450  418  709  459  523

1982
2626 246 2130 2986 2887 2430 2375 2417 2300 2383
 959 1698   83  290  524  619  882  500  684

1983
2751 291 2230 2947 3063 2588 2467 2536 2340 2509
1017 1741  118  293  592  686  969  518  683

1984
2902 302 2386 3217 3256 2728 2602 2665 2548 2681
1098 1690  114  314  661  796 1077  606  771
```

```
1985
3011 381 2537 3406 3407 2859 2756 2790 2648 2786
1255 1990  139  371  729  952 1249  690  891

1986
3149 375 2603 3634 3602 2954 2827 2866 2678 2763
1238 2279  156  330  838 1082 1381 1012 1218

;
DATA COMBO;
 SET ALL1.ALL5;

IF Y=87 THEN DELETE;

PROC SORT  DATA=DATA1;
 BY Y;

PROC SORT  DATA=COMBO;
 BY Y;

DATA MERGED;
 MERGE DATA1 COMBO;
 BY Y;

DATA DD1.LASCOM3;
 SET MERGED;

IF NEC=3353 OR NEC=3363 THEN EM=1;
 ELSE EM=0;
IF NEC=3354 OR NEC=3364 THEN ET=1;
 ELSE ET=0;
IF NEC=3355 OR NEC=3365 THEN MM=1;
 ELSE MM=0;
IF NEC=3356 OR NEC=3366 THEN ELT=1;
 ELSE ELT=0;

IF Y=76 THEN Y0=1;
 ELSE Y0=0;
IF Y=77 THEN Y1=1;
  ELSE Y1=0;
IF Y=78 THEN Y2=1;
  ELSE Y2=0;
IF Y=79 THEN Y3=1;
  ELSE Y3=0;
IF Y=80 THEN Y4=1;
  ELSE Y4=0;
IF Y=81 THEN Y5=1;
  ELSE Y5=0;
IF Y=82 THEN Y6=1;
  ELSE Y6=0;
IF Y=83 THEN Y7=1;
  ELSE Y7=0;
IF Y=84 THEN Y8=1;
  ELSE Y8=0;
IF Y=85 THEN Y9=1;
  ELSE Y9=0;
IF Y=86 THEN Y10=1;
  ELSE Y10=0;

IF MARSTAT=2 THEN MARRIED=1;
 ELSE MARRIED=0;
IF MARSTAT=1 THEN SINGLE=1;
 ELSE SINGLE=0;

//
/*
```

LOGIT MODEL

```
//PROC72    JOB (0529,9999),'COOK 649-3913',CLASS=G
//*MAIN SYSTEM=SY2
//   EXEC SAS
//WORK DD SPACE=(CYL,(20,20))
//ALL DD DISP=SHR,DSN=MSS.S0529.COMBO3
//SYSIN DD *
//

           DATA UN_LEAD;
            INPUT  Y 1-4  UNAGLEAD 6-9 .1  UNMNLEAD 11-14 .1  MLEAD 16-21 .2
                   U24ALEAD 23-26 .1  U59ALEAD 28-31 .1  U34ALEAD 33-36 .1
                   UWM59ALD 38-41 .1  UBM59ALD 43-46 .1
               #2  U24BLEAD 3-6 .1 U59BLEAD 8-11 .1 U34BLEAD 13-16 .1
                   UWM59BLD 18-21 .1  UBM59BLD 23-26 .1
           ;
           CARDS;

NOTE: DATA SET WORK.UN_LEAD HAS 11 OBSERVATIONS AND 14 VARIABLES. 404 OBS/TRK.
NOTE: THE DATA STATEMENT USED 0.10 SECONDS AND 544K.

           ;

           DATA COMBO4;
            SET ALL.LASCOM3;

           IF DIFF GT 725 AND DIFF LT 735 THEN AUTO=1;
             ELSE AUTO=0;

           IF EXT=1 AND AUTO=1 THEN DELETE;

           IF EXT=1 AND AUTO=0 THEN EXT1=1;
             ELSE EXT1=0;

           IF Y=75 THEN DELETE;
           IF Y=87 THEN DELETE;


           IF PAYGRD LE 5 THEN BASEPAY=BPAYE5_6;
           IF PAYGRD GE 6 AND YOS LT 8 THEN BASEPAY=BPAYE6_6;
           IF PAYGRD GE 6 AND YOS GE 8 THEN BASEPAY=BPAYE6_8;

           IF PAYGRD LE 5 THEN BAQ=BAQ5;
           IF PAYGRD GT 5 THEN BAQ=BAQ6;

           IF PAYGRD LE 5 AND YOS LT 5 THEN SEAPAY=0;
           IF PAYGRD LE 5
               AND YOS GE 5 AND YOS LT 6 THEN SEAPAY=SEPAY5_3;
           IF PAYGRD LE 5
               AND YOS GE 6 AND YOS LT 7 THEN SEAPAY=SEPAY5_4;
           IF PAYGRD LE 5
               AND YOS GE 7 AND YOS LT 8 THEN SEAPAY=SEPAY5_5;
           IF PAYGRD LE 5
               AND YOS GE 8 AND YOS LT 9 THEN SEAPAY=SEPAY5_6;
           IF PAYGRD LE 5
               AND YOS GE 9 THEN SEAPAY=SEPAY5_7;
           IF PAYGRD GE 6 AND YOS LE 5 THEN SEAPAY=0;
           IF PAYGRD GE 6
               AND YOS GE 5 AND YOS LT 6 THEN SEAPAY=SEPAY6_3;
           IF PAYGRD GE 6
               AND YOS GE 6 AND YOS LT 7 THEN SEAPAY=SEPAY6_4;
           IF PAYGRD GE 6
               AND YOS GE 7 AND YOS LT 8 THEN SEAPAY=SEPAY6_5;
           IF PAYGRD GE 6
               AND YOS GE 8 AND YOS LT 9 THEN SEAPAY=SEPAY6_6;
```

```
        IF PAYGRD GE 6
            AND YOS GE 9 THEN SEAPAY=SEPAY6_7;

        IF NEC=3353 OR NEC=3363 AND YOS LT 6 THEN SRBMULT=EMSRBA;
        IF NEC=3353 OR NEC=3363 AND YOS GE 6 THEN SRBMULT=EMSRBB;
        IF NEC=3354 OR NEC=3364 AND YOS LT 6 THEN SRBMULT=ETSRBA;
        IF NEC=3354 OR NEC=3364 AND YOS GE 6 THEN SRBMULT=ETSRBB;
        IF NEC=3355 OR NEC=3365 AND YOS LT 6 THEN SRBMULT=MMSRBA;
        IF NEC=3355 OR NEC=3365 AND YOS GE 6 THEN SRBMULT=MMSRBB;
        IF NEC=3356 OR NEC=3366 AND YOS LT 6 THEN SRBMULT=ELSRBA;
        IF NEC=3356 OR NEC=3366 AND YOS GE 6 THEN SRBMULT=ELSRBB;


        SRB=BASEPAY*SRBMULT*3;
        IF Y LT 80 AND SRB GT 15000 THEN SRB=15000;
        IF Y GE 80 AND Y LT 84 AND SRB GT 20000 THEN SRB=20000;
        IF Y GE 84 AND SRB GT 30000 THEN SRB=30000;

        MILPAY = BASEPAY + BAQ + SEAPAY +SRB/36;

        P1=CPAYE331*NUME331;
        P2=CPAYE334*NUME334;
        P3=CPAYE343*NUME343;
        P4=CPAYE346*NUME346;
        P5=CPAYE349*NUME349;
        P6=CPAYE352*NUME352;
        P7=CPAYE390*NUME390;
        P8=CPAYE408*NUME408;
        P9=CPAYE414*NUME414;
        P1MOD=P1*1.1;
        NP1=NCPE331*NNUM331;
        NP2=NCPE334*NNUM334;
        NP3=NCPE343*NNUM343;
        NP4=NCPE346*NNUM346;
        NP5=NCPE349*NNUM349;
        NP6=NCPE352*NNUM352;
        NP7=NCPE390*NNUM390;
        NP8=NCPE408*NNUM408;
        NP9=NCPE414*NNUM414;
        NP1MOD=NP1*1.1;
        TOT=NUME331+NUME334+NUME343+NUME346+NUME349+NUME352
           +NUME390+NUME408+NUME414;
        NTOT=NNUM331+NNUM334+NNUM343+NNUM346+NNUM349+NNUM352
           +NNUM390+NNUM408+NNUM414;
        NUMERAT = P1+P2+P3+P4+P5+P6+P7+P8+P9;
        NNUMERAT = NP1+NP2+NP3+NP4+NP5+NP6+NP7+NP8+NP9;
            CIVPAY = NUMERAT * 1.5 / TOT;
            NCIVPAY = NNUMERAT * 1.5 / NTOT;
        LABEL CIVPAY='WEIGHTED AVG OF NUC INDUSTRY MONTHLY PAY';
        LABEL NCIVPAY='WEIGHTED AVG OF LAGGED NUC MONTHLY PAY';

        CPAYMM=(P2+P8)*1.3/(NUME334+NUME408);
        CPAYEM=(P1MOD+P9)*1.4/(NUME331+NUME414);
        CPAYET=(P1MOD+P7)*1.5/(NUME331+NUME390);
        CPAYELT=(P3+P4+P5+P6)*1.4/(NUME343+NUME346+NUME349+NUME352);
        NCPAYMM=(NP2+NP8)*1.3/(NNUM334+NNUM408);
        NCPAYEM=(NP1MOD+NP9)*1.4/(NNUM331+NNUM414);
        NCPAYET=(NP1MOD+NP7)*1.5/(NNUM331+NNUM390);
        NCPAYELT=(NP3+NP4+NP5+NP6)*1.4/(NNUM343+NNUM346+NNUM349+NNUM352);


        POSITMM=NNUM334;
        POSITEM=(NNUM331+NNUM414)/2;
        POSITET=(NNUM331+NNUM390)/2;
        POSITELT=(NNUM343+NNUM346+NNUM349+NNUM352)/4;

        IF YOS LE 6 THEN FIRST=1;
          ELSE FIRST=0;
```

```
      U_WMAVG=0.5*(UWM2529A+UWM2529B);

NOTE: DATA SET WORK.COMBO4 HAS 12955 OBSERVATIONS AND 211 VARIABLES. 26 OBS/TRK.
NOTE: THE DATA STATEMENT USED 11.37 SECONDS AND 564K.

      PROC SORT  DATA=UN_LEAD;
       BY Y;

NOTE: 4 CYLINDERS DYNAMICALLY ALLOCATED ON SYSDA FOR EACH OF 3 SORT WORK DATA SETS
NOTE: DATA SET WORK.UN_LEAD HAS 11 OBSERVATIONS AND 14 VARIABLES. 404 OBS/TRK.
ONOTE: THE PROCEDURE SORT USED 0.64 SECONDS AND 960K.

      PROC SORT  DATA=COMBO4;
       BY Y;

NOTE: 46 CYLINDERS DYNAMICALLY ALLOCATED ON SYSDA FOR EACH OF 3 SORT WORK DATA SETS
NOTE: DATA SET WORK.COMBO4 HAS 12955 OBSERVATIONS AND 211 VARIABLES. 26 OBS/TRK.
NOTE: THE PROCEDURE SORT USED 8.37 SECONDS AND 1020K.

      DATA COMBO5;
       MERGE UN_LEAD COMBO4;
        BY Y;

      IF EM=1 THEN PAYRATIO=MILPAY/NCPAYEM;
      IF ET=1 THEN PAYRATIO=MILPAY/NCPAYET;
      IF MM=1 THEN PAYRATIO=MILPAY/NCPAYMM;
      IF ELT=1 THEN PAYRATIO=MILPAY/NCPAYELT;

      PAYLAG=LAG1(PAYRATIO);
      PAYLAG2=LAG2(PAYRATIO);
      PAYLAG3=LAG3(PAYRATIO);

NOTE: DATA SET WORK.COMBO5 HAS 12955 OBSERVATIONS AND 228 VARIABLES. 24 OBS/TRK.
NOTE: THE DATA STATEMENT USED 6.79 SECONDS AND 608K.

      DATA MULT_ALL;
       SET COMBO5;
       IF REENLIST=1 OR SEP=1 OR EXT1=1;

NOTE: DATA SET WORK.MULT_ALL HAS 11830 OBSERVATIONS AND 228 VARIABLES. 24 OBS/TRK.
NOTE: THE DATA STATEMENT USED 5.38 SECONDS AND 556K.

      DATA MULTI_R;
       SET COMBO5;
       IF REENLIST=1 OR SEP=1;

NOTE: DATA SET WORK.MULTI_R HAS 11245 OBSERVATIONS AND 228 VARIABLES. 24 OBS/TRK.
NOTE: THE DATA STATEMENT USED 5.17 SECONDS AND 556K.

      DATA MULTI_E;
       SET COMBO5;
       IF EXT1=1 OR SEP=1;

NOTE: DATA SET WORK.MULTI_E HAS 10538 OBSERVATIONS AND 228 VARIABLES. 24 OBS/TRK.
NOTE: THE DATA STATEMENT USED 4.99 SECONDS AND 556K.
```

```
        PROC LOGIST     DATA=MULT_ALL;
         TITLE1 'COOK -- 649-3913';
         TITLE2 'REENLISTMENT LOGIT MODEL';
         TITLE3 'SAMPLE INCLUDES ALL REENLISTERS, EXTENDERS, AND SEPARATORS';
          MODEL REENLIST     =
                               AGE
                               MARRIED FIRST UNEMPMEN
                               EM ET ELT AFQT PAYLAG
                               Y2 Y3 Y4 Y5 Y6 Y7 Y8 Y9
        ;


 NOTE: LOGIST IS SUPPORTED BY THE AUTHOR, NOT BY SAS INSTITUTE INC.
 NOTE:  6935 OBSERVATIONS STORED IN UTILITY FILE
 NOTE: FRANK E. HARRELL, JR.              CLINICAL BIOSTATISTICS
 NOTE: BOX 3363, DUKE UNIVERSITY MEDICAL CENTER, DURHAM NC 27710
 NOTE: THE PROCEDURE LOGIST USED 147.48 SECONDS AND 976K AND PRINTED PAGE 1.

        PROC LOGIST     DATA=MULT_ALL;
         TITLE2 'EXTENSION LOGIT MODEL';
          MODEL EXT1         =
                               AGE
                               MARRIED FIRST UNEMPMEN
                               EM ET ELT AFQT PAYLAG
                               Y2 Y3 Y4 Y5 Y6 Y7 Y8 Y9
        ;


 NOTE: LOGIST IS SUPPORTED BY THE AUTHOR, NOT BY SAS INSTITUTE INC.
0NOTE:  6935 OBSERVATIONS STORED IN UTILITY FILE
 NOTE: FRANK E. HARRELL, JR.              CLINICAL BIOSTATISTICS
 NOTE: BOX 3363, DUKE UNIVERSITY MEDICAL CENTER, DURHAM NC 27710
 NOTE: THE PROCEDURE LOGIST USED 147.96 SECONDS AND 976K AND PRINTED PAGE 2.
0NOTE: SAS INSTITUTE INC.
       SAS CIRCLE
       PO BOX 8000
       CARY, N.C. 27511-8000
+
```

MULTINOMIAL LOGIT MODEL

```
//PROC71    JOB (0529,9999),'COOK 649-3913',CLASS=G
//*MAIN SYSTEM=SY2
//   EXEC SAS
//WORK DD SPACE=(CYL,(20,20))
//ALL DD DISP=SHR,DSN=MSS.S0529.COMBO3
//SYSIN DD *
//

**********************************************************************
|   PROGRAMMING STEPS ARE THE SAME AS FOR THE LOGIT MODEL, BUT THE   |
|        PROCEDURE IS RUN ON DIFFERENT DATA SETS                     |
**********************************************************************

           PROC LOGIST     DATA=MULTI_R;
            TITLE1 'COOK -- 649-3913';
            TITLE2 'REENLISTMENT LOGIT MODEL';
             MODEL REENLIST     =
                                   AGE
                                   MARRIED FIRST UNEMPMEN
                                   EM ET ELT AFQT PAYLAG
                                   Y2 Y3 Y4 Y5 Y6 Y7 Y8 Y9
           ;


 NOTE: LOGIST IS SUPPORTED BY THE AUTHOR, NOT BY SAS INSTITUTE INC.
0NOTE:  6350 OBSERVATIONS STORED IN UTILITY FILE
 NOTE: FRANK E. HARRELL, JR.              CLINICAL BIOSTATISTICS
 NOTE: BOX 3363, DUKE UNIVERSITY MEDICAL CENTER, DURHAM NC 27710
 NOTE: THE PROCEDURE LOGIST USED 140.84 SECONDS AND 976K AND PRINTED PAGE 1.

           PROC LOGIST     DATA=MULTI_E;
            TITLE2 'EXTENSION LOGIT MODEL';
             MODEL EXT1         =
                                   AGE
                                   MARRIED FIRST UNEMPMEN
                                   EM ET ELT AFQT PAYLAG
                                   Y2 Y3 Y4 Y5 Y6 Y7 Y8 Y9
           ;



 NOTE: LOGIST IS SUPPORTED BY THE AUTHOR, NOT BY SAS INSTITUTE INC.
0NOTE:  5643 OBSERVATIONS STORED IN UTILITY FILE
 NOTE: FRANK E. HARRELL, JR.              CLINICAL BIOSTATISTICS
 NOTE: BOX 3363, DUKE UNIVERSITY MEDICAL CENTER, DURHAM NC 27710
 NOTE: THE PROCEDURE LOGIST USED 131.64 SECONDS AND 976K AND PRINTED PAGE 2.
0NOTE: SAS INSTITUTE INC.
       SAS CIRCLE
       PO BOX 8000
       CARY, N.C. 27511-8000
+
```

MODEL B REGRESSIONS

```
//MOD2D20   JOB (0529,9999),'COOK 649-3913',CLASS=C
//*MAIN SYSTEM=SY2
//   EXEC SAS
//WORK DD SPACE=(CYL,(10,10))
//SYSIN DD *
//

         DATA RATES;
           INPUT OBS 1-2  Y 4-5  EM 7  ET 9  MM 11  ELT 13  R_E_RATE 17-21.3
                 EXT_RATE 23-27.3
             #2  YEAR 1-4  UNEMPAG 6-9 .1  UNEMPMEN 11-14 .1  MFGAWE 16-21 .2
                 U_M2024A 23-26 .1  U_M2529A 28-31 .1  U_M3034A 33-36 .1
                 UWM2529A 38-41 .1  UBM2529A 43-46 .1
             #3  CPAYE331 1-4  PREME331 6-8  CPAYE334 10-13  CPAYE343 15-18
                 CPAYE346 20-23  CPAYE349 25-28  CPAYE352 30-33  CPAYE390 35-38
                 CPAYE408 40-43  CPAYE414 45-48
             #4  NUME331 1-4  NUME334 6-9  NUME343 11-14
                 NUME346 16-19  NUME349 21-24  NUME352 26-29  NUME390 31-34
                 NUME408 36-39  NUME414 41-44
             #5  EMSRBA 1-3 .1  EMSRBB 5-7 .1  ETSRBA 9-11 .1  ETSRBB 13-15 .1
                 ELSRBA 17-19 .1  ELSRBB 21-23 .1  MMSRBA 25-27 .1
                 MMSRBB 29-31 .1
             #6  PSAWE 1-6 .2  CPI 8-12 .1  BPAYE5_6 14-20 .2  BPAYE6_6 22-28 .2
                 BPAYE6_8 30-36 .2  BAQ5 38-43 .2  BAQ6 45-50 .2
             #7  U_M2024B 3-6 .1 U_M2529B 8-11 .1 U_M3034B 13-16 .1
                 UWM2529B 18-21 .1  UBM2529B 23-26 .1
             #8  NPO331 3-6  VAC331 8-10  NPO334 12-15  VAC334 17-19
                 NPO349 21-24  VAC349 26-28  NPO343 30-33  VAC343 35-37
                 NPO390 39-42  VAC390 44-46  NPO408 48-51  VAC408 53-55
                 NPO414 57-60  VAC414 62-64
             #9  NPOTRO 3-5  VACTRO 7-8  NPOTNL 10-12  VACTNL 14-15
            #10  SEPAY5_9 3-5  SEPAY5_8 7-9  SEPAY5_7 11-13  SEPAY5_6 15-17
                 SEPAY5_5 19-21  SEPAY5_4 23-25  SEPAY5_3 27-29
            #11  SEPAY6_9 3-5  SEPAY6_8 7-9  SEPAY6_7 11-13  SEPAY6_6 15-17
                 SEPAY6_5 19-21  SEPAY6_4 23-25  SEPAY6_3 27-29
            #12  YEAR 1-4
            #13  NCPE331 1-4  PREME331 6-8  NCPE334 10-13  NCPE343 15-18
                 NCPE346 20-23  NCPE349 25-28  NCPE352 30-33  NCPE390 35-38
                 NCPE408 40-43  NCPE414 45-48
            #14  NNUM331 1-4  NNUM334 6-9  NNUM343 11-14
                 NNUM346 16-19  NNUM349 21-24  NNUM352 26-29  NNUM390 31-34
                 NNUM408 36-39  NNUM414 41-44
            #15  Y 1-4  UNAGLEAD 6-9 .1  UNMNLEAD 11-14 .1  MLEAD 16-21 .2
                 U24ALEAD 23-26 .1  U59ALEAD 28-31 .1  U34ALEAD 33-36 .1
                 UWM59ALD 38-41 .1  UBM59ALD 43-46 .1
            #16  U24BLEAD 3-6 .1 U59BLEAD 8-11 .1 U34BLEAD 13-16 .1
                 UWM59BLD 18-21 .1  UBM59BLD 23-26 .1
            #17  NOTHING 1
         ;

         IF Y=77 THEN Y1=1;
           ELSE Y1=0;
         IF Y=78 THEN Y2=1;
           ELSE Y2=0;
         IF Y=79 THEN Y3=1;
           ELSE Y3=0;
         IF Y=80 THEN Y4=1;
           ELSE Y4=0;
         IF Y=81 THEN Y5=1;
           ELSE Y5=0;
         IF Y=82 THEN Y6=1;
           ELSE Y6=0;
         IF Y=83 THEN Y7=1;
           ELSE Y7=0;
```

```
IF Y=84 THEN Y8=1;
  ELSE Y8=0;
IF Y=85 THEN Y9=1;
  ELSE Y9=0;
IF Y=86 THEN Y10=1;
  ELSE Y10=0;


IF Y=75 THEN DELETE;
IF Y=87 THEN DELETE;

P1=CPAYE331*NUME331;
P2=CPAYE334*NUME334;
P3=CPAYE343*NUME343;
P4=CPAYE346*NUME346;
P5=CPAYE349*NUME349;
P6=CPAYE352*NUME352;
P7=CPAYE390*NUME390;
P8=CPAYE408*NUME408;
P9=CPAYE414*NUME414;
P1MOD=P1*1.1;
NP1=NCPE331*NNUM331;
NP2=NCPE334*NNUM334;
NP3=NCPE343*NNUM343;
NP4=NCPE346*NNUM346;
NP5=NCPE349*NNUM349;
NP6=NCPE352*NNUM352;
NP7=NCPE390*NNUM390;
NP8=NCPE408*NNUM408;
NP9=NCPE414*NNUM414;
NP1MOD=NP1*1.1;
TOT=NUME331+NUME334+NUME343+NUME346+NUME349+NUME352
   +NUME390+NUME408+NUME414;
NTOT=NNUM331+NNUM334+NNUM343+NNUM346+NNUM349+NNUM352
   +NNUM390+NNUM408+NNUM414;
NUMERAT = P1MOD+P2+P3+P4+P5+P6+P7+P8+P9;
NNUMERAT = NP1MOD+NP2+NP3+NP4+NP5+NP6+NP7+NP8+NP9;

    CIVPAY = NUMERAT * 1.5 / TOT;
    NCIVPAY = NNUMERAT * 1.5 / NTOT;
LABEL CIVPAY='WEIGHTED AVG OF NUC INDUSTRY MONTHLY PAY';
LABEL NCIVPAY='WEIGHTED AVG OF LAGGED NUC MONTHLY PAY';

CPAYMM=(P2+P8)*1.3/(NUME334+NUME408);
CPAYEM=(P1MOD+P9)*1.4/(NUME331+NUME414);
CPAYET=(P1MOD+P7)*1.5/(NUME331+NUME390);
CPAYELT=(P3+P4+P5+P6)*1.4/(NUME343+NUME346+NUME349+NUME352);
NCPAYMM=(NP2+NP8)*1.3/(NNUM334+NNUM408);
NCPAYEM=(NP1MOD+NP9)*1.4/(NNUM331+NNUM414);
NCPAYET=(NP1MOD+NP7)*1.5/(NNUM331+NNUM390);
NCPAYELT=(NP3+NP4+NP5+NP6)*1.4/(NNUM343+NNUM346+NNUM349+NNUM352);


BASEPAY=0.63*(0.79*BPAYE5_6 + 0.21*BPAYE6_6) + 0.37*BPAYE6_8;

BAQ=0.63*(0.79*BAQ5 + 0.21*BAQ6) + 0.37*BAQ6;

IF EM=1 THEN SRB=(0.63*EMSRBA + 0.37*EMSRBB)*BASEPAY*3;
IF ET=1 THEN SRB=(0.63*ETSRBA + 0.37*ETSRBB)*BASEPAY*3;
IF MM=1 THEN SRB=(0.63*MMSRBA + 0.37*MMSRBB)*BASEPAY*3;
IF ELT=1 THEN SRB=(0.63*ELSRBA + 0.37*ELSRBB)*BASEPAY*3;

IF Y LT 80 AND SRB GT 15000 THEN SRB=15000;
IF Y GE 80 AND Y LT 84 AND SRB GT 20000 THEN SRB=20000;
IF Y GE 84 AND SRB GT 30000 THEN SRB=30000;

MILPAY=BASEPAY + BAQ + SRB/36;
```

```
127          IF EM=1 THEN PAYRATIO=MILPAY/NCPAYEM;
128          IF ET=1 THEN PAYRATIO=MILPAY/NCPAYET;
129          IF MM=1 THEN PAYRATIO=MILPAY/NCPAYMM;
130          IF ELT=1 THEN PAYRATIO=MILPAY/NCPAYELT;
131
132          PAYLAG=LAG4(PAYRATIO);
133          PAYLAG2=LAG8(PAYRATIO);
134          PAYLAG3=LAG12(PAYRATIO);
135
136
137          CARDS;

NOTE: DATA SET WORK.RATES HAS 49 OBSERVATIONS AND 172 VARIABLES. 34 OBS/TRK.
NOTE: THE DATA STATEMENT USED 0.90 SECONDS AND 560K.

971          ;
972
973
974
975          DATA H_P;
976            SET RATES;
977          LOG_R=LOG(R_E_RATE/(1-(R_E_RATE+EXT_RATE)));
978          LOG_E=LOG(EXT_RATE/(1-(R_E_RATE+EXT_RATE)));
979          LOG_T=LOG((R_E_RATE+EXT_RATE)/(1-R_E_RATE-EXT_RATE));
980

NOTE: MISSING VALUES WERE GENERATED AS A RESULT OF PERFORMING
      AN OPERATION ON MISSING VALUES.
      EACH PLACE IS GIVEN BY: (NUMBER OF TIMES) AT (LINE):(COLUMN).
      5 AT 977:7   5 AT 978:7   5 AT 979:7
NOTE: DATA SET WORK.H_P HAS 49 OBSERVATIONS AND 175 VARIABLES. 32 OBS/TRK.
NOTE: THE DATA STATEMENT USED 0.27 SECONDS AND 560K.

981          PROC REG  DATA=RATES  SIMPLE;
982           TITLE1 'COOK -- 649-3913';
983           TITLE2 'FIRST MODEL B REGRESSION';
984            MODEL R_E_RATE EXT_RATE = PAYLAG
985                                      UNEMPMEN
986                                      Y2 Y3 Y4 Y5 Y6 Y7 Y8 Y9
987                                      EM ET ELT
988          ;
989
NOTE: ACOV AND SPEC OPTION ONLY VALID WITH RAWDATA
NOTE: ACOV AND SPEC OPTION ONLY VALID WITH RAWDATA
NOTE: THE PROCEDURE REG USED 0.23 SECONDS AND 952K AND PRINTED PAGES 1 TO 2.

990          PROC REG  DATA=H_P    SIMPLE;
991           TITLE2 'HOSEK AND PETERSON TRANSFORMATIONS';
992            MODEL LOG_R   LOG_E     = PAYLAG
993                                      UNEMPMEN
994                                      Y2 Y3 Y4 Y5 Y6 Y7 Y8 Y9
995                                      EM ET ELT
996          ;
997
998
NOTE: ACOV AND SPEC OPTION ONLY VALID WITH RAWDATA
NOTE: ACOV AND SPEC OPTION ONLY VALID WITH RAWDATA
NOTE: THE PROCEDURE REG USED 0.24 SECONDS AND 952K AND PRINTED PAGES 3 TO 4.
NOTE: SAS USED 952K MEMORY.
ONOTE: SAS INSTITUTE INC.
      SAS CIRCLE
      PO BOX 8000
      CARY, N.C. 27511-8000
+
```

```
//TSCS13 JOB (0529,9999),'COOK 649-3913',CLASS=B
//*MAIN SYSTEM=SY2
//   EXEC SAS
//FT16F001 DD UNIT=SYSDA,SPACE=(TRK,(10,10)),
//  DCB=(RECFM=VBS,LRECL=2602,BLKSIZE=2606)
//SYSIN DD *
//

          DATA RATES;
            INPUT OBS 1-2  Y 4-5  EM 7  ET 9  MM 11  ELT 13  R_E_RATE 17-21.3
                  EXT_RATE 23-27.3
              #2  YEAR 1-4  UNEMPAG 6-9 .1  UNEMPMEN 11-14 .1  MFGAWE 16-21 .2
                  U_M2024A 23-26 .1  U_M2529A 28-31 .1  U_M3034A 33-36 .1
                  UWM2529A 38-41 .1  UBM2529A 43-46 .1
              #3  CPAYE331 1-4  PREME331 6-8  CPAYE334 10-13  CPAYE343 15-18
                  CPAYE346 20-23  CPAYE349 25-28  CPAYE352 30-33  CPAYE390 35-38
                  CPAYE408 40-43  CPAYE414 45-48
              #4  NUME331 1-4  NUME334 6-9  NUME343 11-14
                  NUME346 16-19  NUME349 21-24  NUME352 26-29  NUME390 31-34
                  NUME408 36-39  NUME414 41-44
              #5  EMSRBA 1-3 .1  EMSRBB 5-7 .1  ETSRBA 9-11 .1  ETSRBB 13-15 .1
                  ELSRBA 17-19 .1  ELSRBB 21-23 .1  MMSRBA 25-27 .1
                  MMSRBB 29-31 .1
              #6  PSAWE 1-6 .2  CPI 8-12 .1  BPAYE5_6 14-20 .2  BPAYE6_6 22-28 .2
                  BPAYE6_8 30-36 .2  BAQ5 38-43 .2  BAQ6 45-50 .2
              #7  U_M2024B 3-6 .1 U_M2529B 8-11 .1 U_M3034B 13-16 .1
                  UWM2529B 18-21 .1  UBM2529B 23-26 .1
              #8  NPO331 3-6  VAC331 8-10  NPO334 12-15  VAC334 17-19
                  NPO349 21-24  VAC349 26-28  NPO343 30-33  VAC343 35-37
                  NPO390 39-42  VAC390 44-46  NPO408 48-51  VAC408 53-55
                  NPO414 57-60  VAC414 62-64
              #9  NPOTRO 3-5  VACTRO 7-8  NPOTNL 10-12  VACTNL 14-15
             #10  SEPAY5_9 3-5  SEPAY5_8 7-9  SEPAY5_7 11-13  SEPAY5_6 15-17
                  SEPAY5_5 19-21  SEPAY5_4 23-25  SEPAY5_3 27-29
             #11  SEPAY6_9 3-5  SEPAY6_8 7-9  SEPAY6_7 11-13  SEPAY6_6 15-17
                  SEPAY6_5 19-21  SEPAY6_4 23-25  SEPAY6_3 27-29
             #12  YEAR 1-4
             #13  NCPE331 1-4  PREME331 6-8  NCPE334 10-13  NCPE343 15-18
                  NCPE346 20-23  NCPE349 25-28  NCPE352 30-33  NCPE390 35-38
                  NCPE408 40-43  NCPE414 45-48
             #14  NNUM331 1-4  NNUM334 6-9  NNUM343 11-14
                  NNUM346 16-19  NNUM349 21-24  NNUM352 26-29  NNUM390 31-34
                  NNUM408 36-39  NNUM414 41-44
             #15  Y 1-4  UNAGLEAD 6-9 .1  UNMNLEAD 11-14 .1  MLEAD 16-21 .2
                  U24ALEAD 23-26 .1  U59ALEAD 28-31 .1  U34ALEAD 33-36 .1
                  UWM59ALD 38-41 .1  UBM59ALD 43-46 .1
             #16  U24BLEAD 3-6 .1 U59BLEAD 8-11 .1 U34BLEAD 13-16 .1
                  UWM59BLD 18-21 .1  UBM59BLD 23-26 .1
             #17  NOTHING 1
          ;

          IF Y=77 THEN Y1=1;
            ELSE Y1=0;
          IF Y=78 THEN Y2=1;
            ELSE Y2=0;
          IF Y=79 THEN Y3=1;
            ELSE Y3=0;
          IF Y=80 THEN Y4=1;
            ELSE Y4=0;
          IF Y=81 THEN Y5=1;
            ELSE Y5=0;
```

```
IF Y=82 THEN Y6=1;
  ELSE Y6=0;
IF Y=83 THEN Y7=1;
  ELSE Y7=0;
IF Y=84 THEN Y8=1;
  ELSE Y8=0;
IF Y=85 THEN Y9=1;
  ELSE Y9=0;
IF Y=86 THEN Y10=1;
  ELSE Y10=0;


IF Y=75 THEN DELETE;
IF Y=87 THEN DELETE;

P1=CPAYE331*NUME331;
P2=CPAYE334*NUME334;
P3=CPAYE343*NUME343;
P4=CPAYE346*NUME346;
P5=CPAYE349*NUME349;
P6=CPAYE352*NUME352;
P7=CPAYE390*NUME390;
P8=CPAYE408*NUME408;
P9=CPAYE414*NUME414;
P1MOD=P1*1.1;
NP1=NCPE331*NNUM331;
NP2=NCPE334*NNUM334;
NP3=NCPE343*NNUM343;
NP4=NCPE346*NNUM346;
NP5=NCPE349*NNUM349;
NP6=NCPE352*NNUM352;
NP7=NCPE390*NNUM390;
NP8=NCPE408*NNUM408;
NP9=NCPE414*NNUM414;
NP1MOD=NP1*1.1;
TOT=NUME331+NUME334+NUME343+NUME346+NUME349+NUME352
   +NUME390+NUME408+NUME414;
NTOT=NNUM331+NNUM334+NNUM343+NNUM346+NNUM349+NNUM352
   +NNUM390+NNUM408+NNUM414;
NUMERAT = P1MOD+P2+P3+P4+P5+P6+P7+P8+P9;
NNUMERAT = NP1MOD+NP2+NP3+NP4+NP5+NP6+NP7+NP8+NP9;

    CIVPAY = NUMERAT * 1.5 / TOT;
    NCIVPAY = NNUMERAT * 1.5 / NTOT;
LABEL CIVPAY='WEIGHTED AVG OF NUC INDUSTRY MONTHLY PAY';
LABEL NCIVPAY='WEIGHTED AVG OF LAGGED NUC MONTHLY PAY';

       CPAYMM=(P2+P8)*1.3/(NUME334+NUME408);
       CPAYEM=(P1MOD+P9)*1.4/(NUME331+NUME414);
       CPAYET=(P1MOD+P7)*1.5/(NUME331+NUME390);
       CPAYELT=(P3+P4+P5+P6)*1.4/(NUME343+NUME346+NUME349+NUME352);
       NCPAYMM=(NP2+NP8)*1.3/(NNUM334+NNUM408);
       NCPAYEM=(NP1MOD+NP9)*1.4/(NNUM331+NNUM414);
       NCPAYET=(NP1MOD+NP7)*1.5/(NNUM331+NNUM390);
       NCPAYELT=(NP3+NP4+NP5+NP6)*1.4/(NNUM343+NNUM346+NNUM349+NNUM352);


BASEPAY=0.63*(0.79*BPAYE5_6 + 0.21*BPAYE6_6) + 0.37*BPAYE6_8;

BAQ=0.63*(0.79*BAQ5 + 0.21*BAQ6) + 0.37*BAQ6;

IF EM=1 THEN SRB=(0.63*EMSRBA + 0.37*EMSRBB)*BASEPAY*3;
IF ET=1 THEN SRB=(0.63*ETSRBA + 0.37*ETSRBB)*BASEPAY*3;
IF MM=1 THEN SRB=(0.63*MMSRBA + 0.37*MMSRBB)*BASEPAY*3;
IF ELT=1 THEN SRB=(0.63*ELSRBA + 0.37*ELSRBB)*BASEPAY*3;

IF Y LT 80 AND SRB GT 15000 THEN SRB=15000;
IF Y GE 80 AND Y LT 84 AND SRB GT 20000 THEN SRB=20000;
```

```
        IF Y GE 84 AND SRB GT 30000 THEN SRB=30000;

        MILPAY=BASEPAY + BAQ + SRB/36;

        IF EM=1 THEN PAYRATIO=MILPAY/NCPAYEM;
        IF MM=1 THEN PAYRATIO=MILPAY/NCPAYMM;
        IF ET=1 THEN PAYRATIO=MILPAY/NCPAYET;
        IF ELT=1 THEN PAYRATIO=MILPAY/NCPAYELT;

        PAYLAG=LAG4(PAYRATIO);
        PAYLAG2=LAG8(PAYRATIO);
        PAYLAG3=LAG12(PAYRATIO);

               IF EM=1 THEN TSCS=1;
               IF ET=1 THEN TSCS=2;
               IF MM=1 THEN TSCS=3;
               IF ELT=1 THEN TSCS=4;


        CARDS;

0NOTE: DATA SET WORK.RATES HAS 44 OBSERVATIONS AND 173 VARIABLES. 32 OBS/TRK.
 NOTE: THE DATA STATEMENT USED 0.87 SECONDS AND 560K.

        ;

        DATA H_P;
          SET RATES;
        LOG_R=LOG(R_E_RATE/(1-(R_E_RATE+EXT_RATE)));
        LOG_E=LOG(EXT_RATE/(1-(R_E_RATE+EXT_RATE)));
        LOG_T=LOG((R_E_RATE+EXT_RATE)/(1-R_E_RATE-EXT_RATE));

 NOTE: DATA SET WORK.H_P HAS 44 OBSERVATIONS AND 176 VARIABLES. 32 OBS/TRK.
 NOTE: THE DATA STATEMENT USED 0.27 SECONDS AND 556K.

        PROC SORT OUT=TSCSDATA DATA=H_P;
         BY TSCS YEAR;


 NOTE: 4 CYLINDERS DYNAMICALLY ALLOCATED ON SYSDA FOR EACH OF 3 SORT WORK DATA SETS.
 NOTE: DATA SET WORK.TSCSDATA HAS 44 OBSERVATIONS AND 176 VARIABLES. 32 OBS/TRK.
 NOTE: THE PROCEDURE SORT USED 0.78 SECONDS AND 940K.

        PROC TSCSREG  DATA=TSCSDATA  TS=11 CS=4 PARKS;
         TITLE1 'COOK -- 649-3913';
         TITLE2 'LOG ODDS REENLISTMENT AND EXTENSION MODELS';
        PARMCARDS;
          MODEL LOG_R            =  PAYLAG
                                    UNEMPMEN
                                    Y2 Y3 Y4 Y5 Y6 Y7 Y8 Y9
                                    EM ET ELT               #

          MODEL LOG_E            =  PAYLAG
                                    UNEMPMEN
                                    Y2 Y3 Y4 Y5 Y6 Y7 Y8 Y9
                                    EM ET ELT               #
        ;

 NOTE: TSCSREG IS NOT SUPPORTED BY THE AUTHOR OR BY SAS INSTITUTE INC.
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+
```

APPENDIX B

This appendix describes the fundamentals of the time series cross sectional data analysis technique used to obtain the results of chapter IV. Refer to Kmenta [Ref. 37, pp.512-514] for details.

The ordinary least squares regression method relies on the assumption that observations are mutually independent of each other. In a data set of the type used in model B of this thesis, such an assumption is probably not valid. The Kmenta text develops a model which takes into account the possibility of the most general non-random error structure. Specifically, it allows for the following forms of the disturbance term, ε:

$$E(\varepsilon_{it}^2) = \sigma_{ii} \qquad \text{(heteroskedasticity)}$$
$$E(\varepsilon_{it}\,\varepsilon_{jt}) = \sigma_{ij} \qquad \text{(mutual correlation)}$$
$$\varepsilon_{it} = \rho_i \varepsilon_{i,t-1} + u_{it} \qquad \text{(serial correlation)}$$

It can be shown that this formulation results in consistent estimates of the regression coefficients and their variances. In addition to performing the transformations required for this specification and determining parameter estimates and standard errors, the SAS routine TSCSREG prints the variance covariance matrix of the disturbance terms u_{it} and values of the serial correlation coefficients ρ.

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